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STUDIES ON SOME IMPORTANT FACTORS INVOLVED IN THE MOLD PROCESS OF MAKING SOY SAUCE

BY VICTORIA A. MASILUÑGAN, MILAGROS A. RAMOS and MACARIO A. PALO

National Institute of Science and Technology, Manila

INTRODUCTION

Soy sauce (or toyo) is a typically Oriental food seasoning held in high favor and used in all Chinese and Japanese cookings. It was the Chinese who discovered that soy sauce is excellent for culinary and table use with soups, vegetables, meat, fish, and fowl. According to Groff (6) the Chinese have been using this condiment for over 3000 years as revealed by records of the ceremonial rites of the Chan Dynasty held before 1000 B. C., for which the king's cook prepared 120 jars of sauces.

Soy sauce has a distinctive flavor which imparts to food a delicious taste, an appetitive fragrance, and nourishment. It is made from soy bean, a leguminous crop which is rich in protein, energy-yielding fat, and carbohydrates. According to Pineda(11) soybean protein is somewhat similar to animal protein.

Introduced by the Chinese in the Philippines through their varied dishes and appetizing menus, soy sauce found ready acceptability among the Filipinos. It is fast becoming an important condiment as shown by the steadfast yearly increase in the utilization of this product since 1951. Consumption in 1956 was valued at 2,677,025 pesos as against only 327,112 pesos for that in 1951.[1]

[1] Figures indicated here were obtained from the Bureau of the Census and Statistics, Manila.

Statistics show that soy sauce manufacture in the Philippines has expanded in recent years and is considered a progressive industry in this country. Local production in 1953 was estimated at 93,120 pesos. In 1956 it leaped to 2,573,977 pesos. Its present tendency is still to go upward as more and more people become familiar with its use as a seasoning agent.

According to Minor(9) there are three or more methods of manufacturing soy sauce. The commoner ones are the mold-enzyme digestion and the acid hydrolysis methods. The first is patterned after the ancient Chinese method of enzyme digestion of protein and starch from a mixture of cooked soybeans and roasted wheat or rice flour. The second consists of refluxing the mixture of soybeans and starchy material in 20 per cent hydrochloric acid until the maximum concentration of amino acids is reached. The third process, for which a U.S. patent was secured by Snelling(13) combines both the moldenzyme and the acid methods. It involves partial hydrolysis of the soybeans with the acid, neutralizing and then completing the hydrolysis with enzymes produced by mold.

Local soy sauce manufacturers prefer the mold-enzyme method because they are familiar with this process and because it does not entail high initial investment. However, they have become lax in maintaining control of the desirable factors affecting the quality of their product, most important of which is its protein content which should not be lower than the standard requirement of 4.5 per cent.

In 1934 Adriano, et al.(1) reported that the protein contents of soy sauce sold in the Philippines varied from 1.58 to 13.37 per cent and that out of eighteen samples of toyo that they analyzed only four met the requirement. Of the six samples analyzed by Soliven and Taracatac(14) in 1957, one was shown to contain only 0.68 per cent protein. The Division of Food and Drug Testing, Bureau of Research and Laboratories, Department of Health, Manila, confirmed the fact that some of our local sauces do not come up to the standard requirement for protein. Adriano, et al.(1) explained that poor enzymic digestion of the food substances in the fermenting mash is the principal cause of usually low protein content of locally manufactured sauce.

In the preparation of quality soy sauce, the molds, especially of the *Aspergillus flavus-oryzæ* group, assume an important role. According to Prescott and Dunn(12) only tested strains,

those which possess enzymes of high proteolytic and amylolytic action, should be used in preparing the starter. If enzymic digestion is carried on under favorable conditions, a high-protein, appetite-stimulating soy sauce can be produced.

The present study is aimed at improving the quality of soy sauce by selecting a superior strain of *Aspergillus flavus-oryzæ* group in preparing the starter; finding the best mixture of soybean and the accessory starch-bearing substance for growth of the selected mold and biosynthesis and activity of the proteolytic and amylolytic enzymes; and determining the right concentration of salt solution, temperature and length of brewing to be adopted to improve quality of soy sauce.

EXPERIMENTAL

MATERIALS AND EQUIPMENT

The materials used in this investigation were as follows: Soybean, Dixie 33 variety (protein content, 41.34 per cent), from San Jose, Batangas; wheat flour, "Gold Medal" brand; salt from Las Piñas, Rizal; tap water from the Manila water-supply system; rice bran from Gapan, Nueva Ecija; and molds of the *aspergillus flavus-oryzæ* group from the stock collection of the National Institute of Science and Technology, Manila.

The following were the equipment used: Pressure cooker for cooking the beans; jars of one-liter capacity; molding chamber; shallow bamboo baskets, known locally as *bistay*, as molding trays; and wide-mouthed bottles of 500-cc capacity for bringing molded beans.

GENERAL PROCEDURE

The following procedure was adopted throughout this investigation unless otherwise modified as indicated elsewhere in the text:

Cooking the beans.—Soybeans in 50-gram batches were soaked in several changes of tap water for 17 to 20 hours. They were washed several times with water. After the water was drained, they were autoclaved for one hour or more or until the beans were soft enough that they would be pressed between fingers.

Molding the beans.—The cooked beans were coated with 25 grams of roasted wheat flour which made the moisture content of the mixture about 60 per cent. They were then seeded with 0.25 gram of a 3-day-old rice bran culture of the proteolytic mold. The seeded beans were spread about ½-in. thick on a

bamboo tray or bistay and incubated in a molding chamber for 3 to 4 days till the surface was profusely covered with the growth of the mold.

Fermenting the molded beans and ripening the fermented products.—The molded beans were transferred to 500-cc bottles into each of which 300 cc of 20 per cent salt solution was added. The bottles were covered with thick Manila paper, shaken and then incubated for four weeks at 40° C. The bottles were shaken daily during the first two weeks of incubation. At the end of four weeks, the fermented product was strained through cheesecloth, and into the filtrate sufficient water was added to restore the volume to the original 300 cc level. The resultant sauce was filtered through filter paper and then analyzed for protein.

Protein determination in the sauce.—The protein content of the sauce was determined by the Kjeldahl process specified in the official and tentative methods of analysis adopted by the Association of Official Agricultural Chemists.(2)

SELECTION OF MOLD FOR SOY SAUCE MANUFACTURE

In the published works of Crewther and Lennox,(4) Groff,(6) Harada,(7) and Thom and Raper(15) the molds of the *Aspergillus flavus-oryzæ* group are shown to be among the most active biochemically. In their studies of protease and amylase of the *shoyu* molds belonging to the *A. flavus-oryzæ* group, Oshima and Church(10) report their production to be individually of different strengths. This being the case, the mold to be used for soy sauce manufacture should come only from strains known or certified to possess the desirable characteristics.

Seven strains of the *Aspergillus flavus-oryzæ* group; namely, NIST–3, –4, –6, –7, –8, –9, and –10, were tested to select the kind of mold to be used later in this investigation. The results are shown in Table 1, which include data on the origin of different strains, on their differences in growth characteristics and proteolytic power, and on the quality of soybean sauce produced by each. The kind of mold used has been found to influence the quality of the sauce produced.

All the molds grew profusely on a combined soybean-wheat flour substratum but all did not sporulate at the same time. NIST–3 sporulated after 96 hours but fructification was sparse and remained even so with age. NIST–10 started to sporulate on the fourth day of incubation but as the culture aged the

TABLE 1.—*Strains of the aspergillus flavus-oryzæ group in the NIST collection and characteristics of the sauce produced by each.*

Culture No	Mold strain	Origin	Growth of Mold		Characteristics of the sauce produced				
			On Czapek's agar	On mixture of cooked soy bean and roasted flour, 4 days old	Color[a]	Odor	Taste	Clarity	Protein content
NIST-3	*Aspergillus oryzæ* (Ahlb.) Cohn 447 111	Bureau of Soils, Manila	Mycelial growth profuse, floccose, white turning later to reddish Yellow (2.5 Y 8/2); Conidial heads sparsely produced.	Mycelial growth luxuriant, white; spores sparse.	Yellow-Red Yellow (10.0 YR 7/8)	Delightful	Savory	Turbid	*Per cent* 4.7
NIST-4	*Aspergillus flavus* Link	do	Colonies nonfloccose, Yellow Green-Yellow (10.0 Y 6/4) during sporulation; conidial heads, abundant, crowded.	Mycelial growth profuse, covered with Yellow Green-Yellow (10.0 Y 5/6) spores.	Yellow-Red Yellow (10.0 YR 7½/1)	Ammoniacal	Slightly bitter	Clear	5.0
NIST-4	*Aspergillus oryzæ* (Ahlb.) Cohn	Dr. Mariano Bascal's collection							
NIST-7	Form, intermediate between *A. flavus* and *oryzæ*	do	Growth profuse with slight floccosity, Yellow (5.0 Y 6/8) to Yellow Green-Yellow (10.0 Y 6/6) to reddish Yellow (2.5 Y 6/4); heavy sporing; formed few dark brown sclerotia.	Mycelial growth profuse, covered with Yellow Green-Yellow (10.0 Y 5/6) spores.	Yellow-Red Yellow (10.0 YR 6/8)	Delightful	Savory	Turbid	4.62
NIST-8	do	Araneta Institute of Agriculture, Caloocan, Rizal	Growth profuse, nonfloccose, Green-Yellow (5.0 GY 5/4) during sporulation; conidial heads abundant.	Mycelial growth profuse, covered with Yellow Green-Yellow (10.0 Y 5/6 spores.	Yellow-Red Yellow (10.0 YR 7/10)	Delightful	Savory	Clear	5.29
NIST-9	do	do	do	do	do	do	do	do	5.28
NIST-10	*Aspergillus oryzæ* (Ahlb.) Cohn	NIST Microbiological laboratory, Alabang	do	do	do	do	do	do	4.60
			Mycelial growth profuse, floccose, white turning to reddish Yellow (2.5 Y 8/4) during sporulation; conidial heads moderately abundant	Mycelial growth, covered with moderately Yellow Green-Yellow (10.0 Y 7/8) spores.	Yellow-Red Yellow (10.0 YR 6/10)	Suave	Savory	Turbid	5.02

[a] Color citations in this article have been made according to the terminology contained in Munsell Book of Color, Munsell Color Co., Inc. Baltimore, Maryland, U.S.A.

conidial heads continued to form until the entire area was covered with them after a week. The other mold strains started to produce the spore heads after the second day and covered the entire growth area with them on the third day.

As shown in Table 1 the sauces produced by different strains had delightful odor and savory taste except the one produced by NIST–4 which emitted ammoniacal odor and tasted bitter. Those produced by NIST–3, NIST–6, and NIST–9 contained less than 5.0 per cent protein and it was only the third which gave a clear product. Those produced by NIST–4 and NIST–10 contained more than 5.0 per cent protein; but they could not be considered good sauces because the first, although clear, was bitter; and the second, although of good taste, was turbid. After comparing the quality and protein content of the sauces produced by the different mold strains, NIST–7 and NIST–8 were the only ones which possessed the desirable characteristics as mold agents for sauce manufacture. Either of the two could be used to advantage in the manufacture of soy sauce, but for purposes of simplifying the investigation NIST–7 was the only strain selected for use in the experiments described hereunder. This selection was not based on certain special cultural features of the strain but simply on the quality and protein content of the sauce produced by it.

USE OF NIST–7 STRAIN OF ASPERGILLUS ORYZÆ WITH VARIOUS SOYBEAN WHEAT FLOUR MIXTURES

Gibbs and Agcaoli(5) state that the starch content of soybean varies from trace to 3.5 per cent. In the present investigation the starch content of the soybean used was 3.62 per cent and this was observed to be somewhat inadequate to support the growth of the NIST–7 strain of *Aspergillus oryzæ*. Wheat flour had to be added to provide sufficient carbohydrate for the normal development of the mold and production of the desired product. Different soybean-wheat flour mixtures were prepared and tried as substrata to determine what influence they would exert upon the mold's growth and the quality of the sauce obtained.

The results given in Table 2 show that in mixtures where the growth of the mold was abundant a higher degree of proteolysis took place, as indicated by the darker color and higher protein content of the sauce obtained. Mixtures which showed moderate development of the mold's mycelium, such as 50.0 : 0.0 and 50.0 : 8.3, produced turbid sauces, indicating that enzymic digestion of protein from the soybean or starch from wheat

TABLE 2.—*Effect of different soybean-wheat flour mixture on the quality of sauces produced from them by Aspergillus oryzae (NIST–7).*

Soybean-wheat flour mixture	Relative amount of mold's growth	Quality of sauces produced after brining mixtures for one month				
		Color	Odor	Clarity	Taste[b]	Protein content
Grams						*Per cent*
50.0:0.0	Moderate	Light tan	Fair	Turbid	Flat	4.30
50.0:8.3	do	do	do	do	do	5.00
50.0:16.6	Abundant	Dark brown	Good	Slightly turbid	Good	5.31
50.0:25.0	do	do	Very good	Clear	do	5.48
50.0:50.0	do	do	do	do	Fair	5.95

flour might be incomplete owing to the absence of sufficient amount of the protease or amylase. The turbidity of the sauce produced from 50.0 : 16.6 mixture might also be due to the same cause. The sauce obtained from 50.0 : 50.0 mixture was dark brown and clear, but it contained some sediment which, when subjected to iodine test, gave a positive reaction for starch. The test showed that the starch was present in so excessive an amount that the enzyme was unable to digest it completely in spite of the great abundance of the growth of the mold's mycelium. The 50.0 : 25.0 mixture produced a clear dark-brown sauce with a pleasant and agreeable aroma and with taste soothing to the palate. When heated, this sauce remained clear. Notwithstanding the fact that its protein content was slightly lower than that produced by the 50.0 : 50.0 mixture, its quality was found superior to that of any of the other sauces obtained in this experiment. The 50.0 : 25.0 mixture was, therefore, selected and adopted in the suceeding studies covering the above subject.

EFFECT OF CONCENTRATION OF SALT SOLUTION ON PROTEOLYSIS OF MOLDED BEANS

Soybeans molded in accordance with our general procedure were grouped into six batches and brined, respectively, in 10, 15, 18, 20, 22 and 25 per cent salt solutions. After four weeks of fermentation at 40° C the sauce produced was filtered and then restored to its original volume of 300 cc per jar.

A close inspection of the results in Table 3 shows that proteolysis of the molded beans is not directly proportional to the salt concentration, that is, the lower the salt concentration the more hydrolized protein is obtain. But, in lower concentrations of salt solution, such as 10 and 15 per cent, the sauce produced

TABLE 3.—*Effect of various concentrations of salt solution on the character of sauce produced from molded soybeans.*

Concentration of salt solution *	Character of soy sauce produced		
	Protein content	Taste	Odor
Per cent	*Per cent*		
10	5.80	Flat, slightly salty	Fair
15	5.62	do	do
18	5.50	Fair, slightly salty	do
20	5.26	Good, fairly salty	do
22	5.22	Good, salty	do
25	5.13	Fair, very salty	Good

was frequently of poor quality owing to the inroads of undesirable organisms which caused the product to emit foul odor. A great many of the harmful contaminants encountered in sauce-making could not tolerate high concentrations but very salty solutions make the sauce less savory and unacceptable. Twenty per cent salt solution is, therefore, the ideal concentration to use for brining molded beans because it produces a sauce of precise palatability and appetizing fragrance with a saltiness satisfactory to the taste yet not so low as to encourage the growth of contaminants.

PROTEIN CONTENTS OF SAUCES PRODUCED BY BRINING BEANS IN DIFFERENT VOLUMES OF 20 PER CENT SALT SOLUTION

Five batches of beans prepared and molded according to the general procedure previously described ahead were brined in jars with 150, 200, 250, 300 and 350 cc of 20 per cent salt solution, respectively. The sauce produced in each jar after four weeks of fermentation at 40° C was filtered and restored to its original volume by adding boiled water. After pasteurization the protein content was determined.

TABLE 4.—*Effect of using different volumes of 20 per cent salt solution on the hydrolysis of protein in molded soybeans.*

Volume of 20 per cent salt solution used for every 50 grams of soybeans	Protein content	
	Per 100 cc of sauce	Of the entire sauce product
cc	*Grams*	*Grams*
150	9.18	13.77
200	7.61	15.22
250	6.33	15.83
300	5.57	16.71
350	4.71	16.48

The result shown in Table 4 reveal that as the volume of the brine was increased from 150 to 350 cc the protein content of the sauce produced decreased from 9.18 to 4.71 grams per 100 cc. Although the 150 cc gave the highest amount of protein per cc, its total protein of 13.77 grams was the least when compared with those of other volumes. It is apparent that as the volume was increased the amount of total protein hydrolyzed was also increased until it reached its peaks of 16.71 grams at 300 cc. A slightly lower total protein was obtained at 350 cc. For the purpose, therefore, of obtaining the highest amount of hydrolized protein from molded beans, the proportion of 50 grams of beans molded in accordance with our procedure with 300 cc of the 20 per cent salt solution (1 kg of beans to 6 liters of salt solution), was adopted in succeeding experiments.

EFFECT OF TEMPERATURE ON THE PROTEOLYSIS OF MOLDED BEANS IN THE BRINE

Reports regarding brining temperatures for sauce production from molded soybean-flour mixture are varied and conflicting. The molded bean mash, according to Prescott and Dunn,(12) is incubated at 35 to 38° C for 30 to 90 days. Sunning the jars containing the molded bean suspension in the yard, as practiced by the Chinese in Sainam City, Kwangtung, China(6) and by local manufacturers(1) expose them to temperatures oscillating from 25° C, or lower, to almost 45° C. According to Harada(7) the diastatic activity of *Aspergillus oryzæ* is greatly affected at high temperatures (above 45° C). Underkofler and Hickey(16) on the other hand state that the protease from various fungi, one of which was *A. oryzæ*, is at its optimum activity at 50° C.

The following experiment was undertaken to determine at which temperature the bean suspension should be fermented to produce the quality of sauce desired: Beans in glass jars, prepared in accordance with our general procedure, were brined in 20.0 per cent salt solution (300 cc per jar) and then grouped into eight batches of 3 jars each. The different batches were fermented at various temperatures; namely, 28 to 31° C (room temperature), 37, 40, 45, 50, 55, 60, and 70° C. After four weeks of fermentation, the percentage of soluble protein in the sauce produced from batch was determined.

As shown in Table 5 the sauce that gave the highest percentage of soluble protein was that produced at room temperature (28 to 31°C). Those produced at 37, 40, 45, and

TABLE 5. —*Effect of temperature on proteolysis of beans in 20 per cent salt solution.*

Temperature	Protein content of sauce produced
Centigrade	*Per cent*
28–31 (room temperature)	5.79
37	5.19
40	5.08
45	5.07
50	5.16
55	4.54
60	3.99
70	3.60

50° C had lower protein contents but the difference between any of them and that produced at room temperature was so slight that no significance could be attached to it. An apparent slackening of proteolysis of the molded soybean took place at 55° C, as indicated by the sudden lowering of the protein content in the sauce produced at this temperature. Proteolysis continued to decline with further rise in temperature, until at 70° C the protein that went into solution was only 3.6 per cent.

Sauces produced at room temperature and at 37° C were frequently unsavory in taste owing to the incursion of putrefying bacteria and other contaminants. On the other hand, the inhibition or destruction of the objectionable microorganisms at 40 and 45° C resulted in the production of clear, palatable sauce; hence, this temperature range (40 to 45° C) was considered to be the optimum for brewing molded beans.

PERIOD OF MOLDING BEANS IN RELATION TO THEIR SUBSEQUENT PROTEOLYSIS IN THE BRINE

Six batches of cooked beans were inoculated with the selected strain of mold (NIST–7); incubated, respectively, for 2, 4, 6, 10, 16, and 20 days at room temperature (28 to 31° C); and then brined in 20 per cent salt solution. After four weeks the protein content of the resulting sauce from each batch was determined.

The results given in Table 6 show that shorter periods of molding the beans cause more of their protein to be hydrolyzed during the brining. A duration of four days was found to be the best. This period almost tallies with the finding of Baens–Arcega, et al.(3) who reported that the duration of incubation for maximum protease formation by a Philippine strain of *A. oryzæ* which they studied was 4 to 5 days in rice bran and 3

TABLE 6.—*Effect of period of molding soybeans on the subsequent proteolysis of beans in 20 per cent salt solution.*

Molding period	Protein content of sauce produced
Days	*Per cent*
2	5.25
4	5.35
6	5.18
10	5.00
16	4.91
20	4.83

days in copra meal and that the amount of available protease decreased as the periods of molding were extended. As the culture of the mold (NIST–7) in cooked beans aged, the amount of soluble protein that went into the sauce produced became less and less showing that the mold's protease had gradually declined in protency.

PROTEIN CONTENT OF SOY SAUCE PRODUCED FROM MASHED MOLDED BEANS

During the course of the present investigation the senior author had thought of a possibility of increasing the protein of soy sauce by mashing molded beans before brining them in order to expose the inner portions to the direct action of the mold's protease. To demonstrate it by experimental evidence, two batches of molded soybeans, the first consisting of whole uncrushed beans and the second composing of mash materials, were prepared and brined in 20.0 per cent salt solution. After four weeks of brining at 40° C the fermented product was filtered and water was added to the resulting sauce to the 300 cc level.

The protein contents of the sauces produced from the two batches were, on the average, 5.36 per cent for whole beans and 5.49 per cent for mashed beans. Since there is not much difference between this two figures, no practical advantage may be gained from mashing molded beans before fermenting them into sauce.

RELATION OF BRINING PERIOD TO THE PROTEOLYSIS OF THE MOLDED SOYBEAN MASH

Four batches of molded beans brined in 20 per cent salt solution, each pH 6.0, were fermented at 28 to 31°C (room temperature), 37, 40, and 45° C, respectively. At the end of

[b] Decision given by taste panel of five persons.

[c] For each bottle in each batch, 300 cc of the salt solution was used for brining 50 grams of molded soybeans.

each week, for six consecutive weeks, the protein contents of the sauces from fermenting molded soybeans mash of each batch was determined.

As shown in Table 7 there was a lowering of pH in all batches except in the one placed at room temperature at which the pH rose to 7.15 at the close of the sixth week. The rise of the pH was due perhaps to the inroads of putrefactive bacteria which grew fast at room temperature. Proteolysis was steadily going on for six weeks at room temperature and, perhaps because of the combined action of the proteolytic enzymes from the inoculated mold and from the bacterial contaminants,

TABLE 7.—*Effect of temperature and duration of fermentation on the protein content of sauce from fermenting molded soybean mash.*

Temperature of fermentation	Initial reaction of mash	Final reaction of mash	Protein content of sauce from the fermenting mash					
			1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week
Centigrade	*pH*	*pH*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
28–31 (Room temperature)	6.0	7.15	4.43	4.93	5.01	5.39	5.32	5.42
37	6.0	4.6	4.77	4.85	5.01	5.19	5.06	5.29
40	6.0	4.6	4.61	4.97	5.00	5.06	5.11	5.23
45	6.0	4.43	4.20	4.94	5.14	5.08	5.00	5.01

the protein content of the batch fermented at this temperature was higher than those produced at higher temperatures. The objectionable features of the soybean sauce produced at room temperature, are unsavoriness and turbidity. However, turbidity could be made to disappear and the taste improved by extending the time of fermentation in the brine to a few months.

Proteolysis of molded beans at temperatures higher than room temperatures appeared to be fast during the first two weeks of fermentation and to have reached its peak at the end of the third or fourth week. After the fourth week it started to slow down or to cease as shown by the decreased or practically unchanged protein contents of the sauces obtained. At 40 and 45° C, it was complete at the end of four weeks and the sauces produced at these temperatures were clear and savory.

SUMMARY

1. Some important factors involved in the mold process of making soy sauce were studied.

2. A general procedure of preparing soy sauce was described and followed in all experiments undertaken.

3. Seven strains of the *Aspergillus flavus-oryzæ* group in the collection of the National Institute of Science and Technology, Manila, were tested as microbial agents in the production of soy sauce. NIST–7, a mold strain which appears to be an intermediate form between *A. flavus* and *A. oryzæ* was found to possess the desirable characteristics for the production of quality soy sauce.

4. A mixture of two parts soybean and one part wheat flour was found to be an ideal substratum for the growth of the selected proteolytic mold because it provided sufficient carbohydrate and the sauce produced was clear, dark brown, with pleasant and agreeable aroma and with taste soothing to the palate.

5. Twenty per cent salt solution is the most ideal concentration for brining the molded beans because it gave a sauce of precise palatability and saltiness satisfactory to the discriminating taste. It should be added at the rate of 300 cc for every 50 grams of molded beans or six liters for every kilogram of molded beans.

6. The temperature considered to be the optimum for brewing molded beans in 20 per cent salt solution into quality soy sauce ranged from about 40 to 45° C.

7. A molding period of 4 days was found sufficient to induce maximum proteolysis of molded beans in subsequent fermentation in the brine.

8. No practical advantage could be derived by mashing molded beans before fermenting them into sauce.

9. Proteolysis of molded beans at 40 and 45 °C was found to be complete after four weeks of fermentation.

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8. No practical advantage could be derived by mashing molded beans before fermenting them into sauce.

9. Proteolysis of molded beans at 40 and 45 °C was found to be complete after four weeks of fermentation.

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2. A general procedure of preparing soy sauce was described and followed in all experiments undertaken.

3. Seven strains of the *Aspergillus flavus-oryzæ* group in the collection of the National Institute of Science and Technology, Manila, were tested as microbial agents in the production of soy sauce. NIST–7, a mold strain which appears to be an intermediate form between *A. flavus* and *A. oryzæ* was found to possess the desirable characteristics for the production of quality soy sauce.

4. A mixture of two parts soybean and one part wheat flour was found to be an ideal substratum for the growth of the selected proteolytic mold because it provided sufficient carbohydrate and the sauce produced was clear, dark brown, with pleasant and agreeable aroma and with taste soothing to the palate.

5. Twenty per cent salt solution is the most ideal concentration for brining the molded beans because it gave a sauce of precise palatability and saltiness satisfactory to the discriminating taste. It should be added at the rate of 300 cc for every 50 grams of molded beans or six liters for every kilogram of molded beans.

6. The temperature considered to be the optimum for brewing molded beans in 20 per cent salt solution into quality soy sauce ranged from about 40 to 45° C.

7. A molding period of 4 days was found sufficient to induce maximum proteolysis of molded beans in subsequent fermentation in the brine.

8. No practical advantage could be derived by mashing molded beans before fermenting them into sauce.

9. Proteolysis of molded beans at 40 and 45 °C was found to be complete after four weeks of fermentation.

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COMPARISON BETWEEN THE EFFECTS OF X-RAYS AND GAMMA RADIATION ON RICE

By Joventino D. Soriano
College of Liberal Arts, University of the Philippines, Quezon City

ONE PLATE

A close similarity in the biological effects of x-ray and gamma radiations has been assumed by most workers on account of their physical properties. Inasmuch as sources of these two kinds of radiations are now available, a comparison of their effects on plants will be of interest in radiological work and in crop improvement programs.

X-rays have been used as a basis for determining the biological effectivity of various radiations and chemical mutagens as shown in the work of Smith,(12) Schmidt and Frolik,(11) MacKay,(7) Nuffer,(10) Steinitz-Sears and Sears,(14) Yagyu and Morris,(15) and others. Matsumura, et al.(9) compared the effects of x-rays and gamma radiation on wheat and found that gamma rays produced more inviable seeds and more pronounced growth retardations than x-rays.

Studies on the biological effects of ionizing radiations on rice (*Oryza sativa* Linn.) have been made by some workers. Matsuo, et al.(8) compared the effects of thermal neutrons and x-rays and reported that the former were more effective than the latter in causing growth inhibitions, chlorophyll deficiencies and spike sterility; Fujii(3) and Fujii and Matsumura(4) on radiosensitivity in rice; and Soriano(13) on chlorophyll mutations and interchange orientations.

MATERIALS AND METHODS

Newly harvested rice seeds of the upland variety Palawan were exposed to x-rays (175 KVP, 20 ma), at a target distance of 3.5 cms and dose rate of 266.5 r per minute and gamma ray

[1] Investigation supported by a grant from the University of the Philippines Research Center.

(Co–60, 0.6–1 kr/hr) at doses of 20, 25, 30, 40, and 50 kr.[2] The sample sizes for the x-ray treatments were 138 seeds at 20 kr, 156 at 25 kr, 129 at 30 kr, 124 at 40 kr, and 133 at 50 kr. For the gamma ray doses, the sample sizes were 125 seeds at 20 kr, 149 at 25 kr, 136 at 30 kr, 108 at 40 kr, and 136 at 50 kr. The control consisted of 150 untreated seeds picked at random from the original seed collection. The Palawan variety is ideal for this kind of study on account of its adaptability to dry conditions in Diliman, its broad leaves making chlorophyll deficiencies easily detected and its early maturity. The experiments were performed at the Liberal Arts Experimental Garden, University of the Philippines, Quezon City.

Slightly affected seedlings were transplanted in field plots about forty-five days after sowing while those that were heavily inhibited in growth were grown in individual pots in the plant house. Variations were observed at different stages in the R_1 generation [3] and at the mature stage at least twenty representative plants were measured for height based on the lowest node to the highest node. The main panicles were harvested as they matured and data for determinations of seed-set were taken. In plant radiation work, gametic fertility is a good index of the occurrence of genetic changes due to treatment.

RESULTS

Seed viability and survival of seedlings.—Percentage germination was used as the basis for determining seed viability after exposure to varying dosages of x-rays and gamma radiation (Table 1). The degrees of seed viability as a result of x-ray treatment were 6.68 per cent at 20 kr, 4.4 per cent at 25 kr, 10.19 per cent at 30 kr, 11.63 per cent at 40 kr, and 12.51 per cent at 50 kr. The degrees of seed inviability as a result of gamma radiation were 2.55 per cent at 20 kr, 2.91 per cent at 25 kr, 32.81 per cent at 30 kr, 88.97 per cent at 40 kr, and 100 per cent at 50 kr. No marked difference in vialibility

[2] In the first experiment, the seeds were treated at the Institute of Agricultural Sciences in Hiratsuka, Japan, through the help of Mr. T. Kawai of that Institute. The results of the first experiment were partly corroborated on by those of a second batch of seeds treated at the Brookhaven National Laboratory, U.S.A., with the help of Dr. S. Shapiro under a research cooperative program.

[3] R_1 generation refers to the treated generation.

TABLE 1.—*Seed variability and survival of rice seedlings after exposure to x-rays and gamma radiations.*

Culture number	Dosage (Kr [1])	Germination	Survival
		Per cent	*Per cent*
0–39062	Control	92.36	100.00
047	20 kr, x-ray	86.95	100.00
048	25 kr, x-ray	88.25	94.34
050	30 kr, x-ray	82.17	90.34
050	40 kr, x-ray	81.50	84.37
051	50 kr, x-ray	80.68	83.57
042	20 kr, gamma ray	90.00	100.09
043	25 kr, gamma ray	90.60	90.29
044	30 kr, gamma ray	62.06	84.61
045	40 kr, gamma ray	10.18	0.0
046	50 kr, gamma ray	0.0	0.0

was observed from the seeds exposed to all the x-ray doses and to those subjected at 20 to 25 kr of gamma radiation. Dosage of 30 kr and above of gamma rays markedly decreased percentage of seeds are shown in Plate 1.

From these results, gamma ray is evidently more effective than x-rays in reducing seed viability at high dosages. LD 50 for gamma radiation was estimated by the author at approximately 33 to 34 kr while LD 100 is situated between 40.1 to 41 kr. For x-ray, LD 50 is beyond 50 kr. When compared with the control, doses of 20 to 50 kr x-rays and 20 to 25 kr gamma rays caused slight reductions in seed viability while higher gamma ray dosages significantly increased the number of inviable seeds.

The percentage of seedling survival was based on the number of plants reaching the two-leaf stage. Normally this stage is attained in about two weeks after emergence for the Palawan variety. No marked difference was observed in the percentage of surviving seedlings after exposure to x-rays and gamma radiation at dosages below 30 kr. This indicates a similarity in the nature of seedling injury produced by the two kinds of radiation at those dosages. The capacity of plants to grow up to the two-leaf stage appears largely dependent on the degree of embryo injury as shown by the early death of seedlings delayed in germination.

Plant height.—Since most of the treated plants were visibly delayed in growth at the seedling stage, the data on plant height were taken (Table 2). The heights of plants treated with doses of 20 to 25 kr x-rays and 20 kr gamma ray did not vary significantly from those of the control.

TABLE 2.—*Mean height of rice plants exposed to x-rays and gamma radiation.*

Dosage and radiation	Seedling stage	Mature stage
	cms	*cms*
Control	7.12+0.45	74.32+1.78
20 kr, x-ray	7.25+0.33	73.86+2.73
25 kr, x-ray	6.75+0.51	72.37+3.99
30 kr, x-ray	3.36+0.70	59.52+4.83
40 kr, x-ray	2.30+0.79	67.46+7.14
50 kr, x-ray	2.27+0.47	67.38+4.67
20 kr, gamma ray	5.47+0.31	73.24+2.31
25 kr, gamma ray	3.77+0.59	71.48+2.44
30 kr, gamma ray	2.74+0.55	67.68+3.46
40 kr, gamma ray	2.21+0.13	
50 kr, gamma ray		

A marked inhibition of growth was observed at doses of 30 to 50 kr x-rays and 25 to 4 kr gamma rays as compared with the control. The difference in the heights of plants exposed to x-ray and gamma radiation was highly significant ($P>0.01$, N=324) indicating that the latter was more effective as a growth inhibitor than the former. Based on the mean heights of the seedlings, a dosage of 30 kr gamma radiation appears as effective as doses of 40 to 50 kr x-ray in causing reduction in growth.

At maturity no significant reduction in height of the plants was evident at 20 to 50 kr x-ray and 20 to 25 kr gamma ray (Table 2). The similarity of plant height in the irradiated and control lots may be due to the death of the heavily inhibited stalks and possibly to the recovery to normal conditions in those that grow to maturity.

Radiation-induced variations.—At least 10 types of variations were induced by x-rays and gamma radiations the most common of which were leaf mottling, narrow leaves, dark-green plant and compact panicle. Variations produced by x-rays were similar to those induced by gamma rays. Not all these variations proved heritable.

Leaf mottling was observed in all plants exposed to 30 to 50 kr of both x-rays and gamma radiation. It occurs as tiny chlorophyll-deficient dots on the blade or midrib. These chlorophyll deficiencies generally result from the death of plastic primordia at the embryo stage due to radiation treatment.

Plants from seeds exposed to doses of 30 to 50 kr x-ray and gamma radiation had narrow leaves measuring approximately ⅔ to ¾ of normal leaves. In most cases only the

first two leaves were small showing that the injury was embryonic in origin. Extreme narrowing was accompanied in some cases by rolling of the leaf blades reducing further the surface area of the leaf.

Dark-green plant was common only at higher levels of radiation. The plants were usually stocky with broad and thick leaves which become firm and rigid when mature. The dark-green color of the leaves was possibly due to an increase in the rate of chlorophyll formation. In most cases, tillers arising from dark-green mother plants were normal showing a possible mosaic effect of radiation of the R_1 plants.

Compact panicle was markedly different from the open normal rice panicle on account of the short branches of the rachis and pedicels. Only heavily inhibited plants of the seedling stage produced compact panicles. The branches and sub-branches of the rachis were short and appressed to the axis of the panicle. Most of the grains on compact panicles were empty.

Seed-set.—Chromosomal changes like breakages and fragment losses cause reduction in the viability of gametophytes in the form of pollen and ovule abortion. The degree of ovule abortion resulting from treatment is indicated by seed-set. The mean number of good seeds per panicle ranged from 7 to 13 for all doses which was equivalent approximately to 4.63 to 7.78 per cent seed-set. No significant differences was observed in the seed-set of plants exposed to the varying doses of x-ray and gamma radiations. As shown in Table 3, ovule abortions ranged from approximately 91.49 to 95.31 per cent showing that x-ray was effective as gamma radiation at doses 20 to

TABLE 3.—*Per cent survival of rice plants exposed to varying doses of x-rays and gamma radiations.*

Culture number	Dose and radiation	Seedling stage	Mature stage
		Per cent	*Per cent*
0-59062	Control	0.0	0.0
047	20 kr, x-ray	1.82	0.88
048	25 kr, x-ray	7.72	1.54
049	30 kr, x-ray	31.40	6.73
050	40 kr, x-ray	67.69	9.42
051	50 kr, x-ray	67.19	9.58
042	20 kr, gamma ray	21.77	1.71
043	25 kr, gamma ray	47.19	1.39
044	30 kr, gamma ray	61.57	9.18
045	40 kr, gamma ray	69.07	
046	50 kr, gamma ray		

50 kr. The equal decreases in seed-set by the two radiations may be due to the very high doses which are beyond levels that would permit comparison of such effects. There was also a marked decrease in the number of florets per panicle at high doses.

DISCUSSION

Matsuo, et al.(8) reported a seed viability of 65 per cent in "Caloro" rice exposed to 40 kr x-rays while Fukii(3) obtained 67 per cent viability at 40 kr and total death of seedlings at 70 kr gamma radiation with *japonica* rice varieties. The deviation of these reports with those of the present tests may be due to delayed action of radiation as demonstrated by Bora(1) who found a rise in the frequency of chromosomal breaks following a lag between irradiation and planting. The biological basis for this phenomenon was supplied by Kuzmin(6) and others who showed that indirect and delayed changes in the genetic material result from slow polymerization chain reactions in the cell.

The nonsurvival of seedlings treated with 40 kr gamma radiation indicates the intense injury on the embryos resulting in the complete cessation of the development process beyond the period of emergence. Carter(2) stated that a number of physiological disturbances are induced in plants by ionizing radiation which inhibit normal growth. Using three *japonica* rice varieties, Fujii and Matsumura(4) obtained a survival range of 77.5 to 81.0 per cent at 20 kr and 26 to 65 per cent at 40 kr gamma rays.

Since not all the induced variations proved heritable, the occurrence of extranuclear changes by both radiations is demonstrated. This possibly explains the similarity in the type and frequency of morphological variations by the two radiations. Cytoplasmic injury is evident from leaf mottling and most types of growth inhibitions. The genetic nature of various kinds of morphological changes has been demonstrated by Smith(12) in wheat who showed that different genotypes are unequally affected by radiation.

The value of seed-set as an early measure of the genetic effects of radiation is based on the fact that chromosomal aberrations are lethal at the gametophyte stage. Using diploid rice, Yamaguchi and Ando(16) obtained 20 per cent sterility at 10 kr and decreasing fertility at higher doses.

Matsuo, et al.(8) demonstrated that reduction of seed-set in rice after irradiation is due to chromosomal aberrations. A lower range of doses should be used in comparing the degree of genetic injury by x-ray and gamma radiations.

SUMMARY

Dry rice seeds of the variety Palawan were exposed to x-ray and gamma radiation at doses of 20, 25, 30, 40, and 50 kr and planted about one month after treatment. A comparison of the effects of these two radiations showed that gamma ray was a more effective agent for reducing seed viability and inhibiting seedling growth than x-ray at higher doses. No difference on the types of induced variations and height of maturity was observed. A comparison of the degree of genetic injury through seed-set was not possible due to the use of very high doses.

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ILLUSTRATIONS

PLATE 1

One-month-old rice seedlings exposed to gamma radiation: *a*, seedlings exposed to 20 kr; *b*, control; *c*, seedlings exposed to 40 kr; *d*, seedlings exposed to 30 kr; *e*, seedlings exposed to 25 kr; *f*, seedlings exposed to 50 kr.

PLATE 1.

NITROGEN CONTENT OF SOME LOCAL AIR-BORNE POLLEN GRAINS IN RELATION TO ALLERGY

By Gloria Laserna, Josefina S. Buenaventura and Joaquin Marañon

National Institute of Science and Technology, Manila

FOUR PLATES

INTRODUCTION

In an earlier report(6) a study of the nitrogen content and the preparation of the sterile extract from talahib (*Saccharum spontaneum* Linn. subsp. *indicum* Hack.) pollen was presented. The water-soluble component of the pollen obtained under the least harsh condition proved to be closely resembling the natural material in the pollen. The extract offered excellent possibilities for clinical tests of the nitrogen in the pollen as a causative agent to allergenic conditions. For this reason, it was decided to extend the study and to survey the nitrogen content of other species of local-airborne pollen grains, such as mais (*Zea mays* Linn.), urai (*Amaranthus spinosus* Linn.), sunflower (*Helianthus annuus* Linn.), foxtail millet [*Pennisetum polystachyon* (Linn.) Schultz], Java grass [*Polytrias praemorsa* (Nées) Hack.], Natal grass [*Rhynchelytrum repens* (Willd.) C. E. Hubb.], and makahiya (*Mimosa pudica* Linn.).

The last four shed pollen rather sparingly, but owing to their great abundance in vast wild abandoned areas they may also be an important cause of hay fever. Grass pollens are light and are more easily dispersed by wind currents to far distances and the irritation caused by them is much more intense than that caused by tree pollen.(10)

Mais pollen was the first selected for this investigation, being the most abundant material available. This material was found in such sufficient amounts as not only to permit the application of the direct micro-colorimetric-Kjeldahl method of Kock and McMeekin(4) for the determination of the nitrogen in the whole pollen but also to determine the nitrogen content of the various extracts made from the pollen.

The data obtained was encouraging and enabled us to pursue the subsequent determinations of the nitrogen content of the

pollens of other species and of the extracts therefrom for diagnostic clinical tests. The determination of the nitrogen content of each pollen extract was necessary since no uniform method of standardization could be adopted.(8)

Different authors(3, 9) have noted the absence of correlation between the allergenic activity and the nitrogen content of the extracts of pollens and their fractions. In view of this, there appears to be no rationale for testing the pollen extracts and fractions on an equal nitrogen basis. The nitrogen unit(8) (0.001 mg), however, has been generally accepted as the criterion for the degree of allergenic activity owing to the lack of knowledge of the precise constitution of the allergenic entity or entities in the pollen grain.

EXPERIMENTAL

Mais pollen was collected from the experimental station of the Bureau of Plant Industry in Manila. Early every morning, for several weeks, the inflorescences were covered with glazed envelopes. Between nine and eleven o'clock in the same morning the covered heads were shaken in order to collect the pollen and anthers. The fallen anthers and pollen were dried at 60° C in the oven and sieved through 70-mesh, and finally through 200-mesh, several times. The pure pollen was collected, brushed into wide-mouthed vials and then placed in a desiccator. The desiccator-dried pollen was defatted with ether through Soxhlet.

Aqueous extraction of nitrogen.—Four grams of desiccator-dried, oil-free corn pollen was macerated in water for five days and a little toluene added; the solution was filtered and made up to 250 cc volume. With 1 cc aliquot for each determination, the nitrogen of the aqueous extract was determined.

The 250 cc aqueous extract was reduced in volume by concentration on a water bath and slightly acidified with 0.5 N acetic acid to precipitate the albuminous substance. This substance was filtered in a tared filter paper, washed with boiling water, alcohol and ether, dried and weighed, and its nitrogen content determined. The filtrate and washings were combined and made up to 100 cc volume. The nitrogen of this combination was also determined with the use of 1 cc aliquot for each determination.

Nitrogen extraction with alcohol.—The original pollen residue collected after filtering the aqueous solution was macerated in 95 per cent alcohol for five days. The alcoholic solution was

filtered and the residue washed with alcohol. The alcoholic filtrate and washings were combined and made up to 100 cc volume. Ten cc aliquot of this combination was reduced to about 1 cc by evaporation on a water bath and used for determining the nitrogen content.

Nitrogen extraction with alkali.—After extraction of nitrogen with alcohol, the pollen residue was dried then macerated in 0.2 per cent KOH for five days. The alkaline solution was filtered, the residue washed, and the extract made up to 100 cc volume. The nitrogen in the solution was determined with the use of 1 cc aliquot.

The remaining 0.2 per cent KOH extract was placed in a small beaker and acidified with hydrochloric acid to pH 6.6 to precipitate the glutelin. The precipitate, which was fine and uniform and easily formed, was transferred in a tared centrifuge tube. This was subjected to centrifugal action and the filtrate decanted and made up to 100 cc volume. Nitrogen was determined with the use of 2 cc aliquot. The precipitate, as glutelin substance, was dried in the tared centrifuge tube and weighed. The nitrogen content was determined by dissolving the substance in sulphuric acid.

Residual nitrogen.—The nitrogen of the original pollen residue left after the extractions with various solvents was also determined.

RESULTS AND OBSERVATIONS

As shown in Table 1, only 0.026 per cent or 0.7 per cent of the nitrogen content of the whole corn pollen was extracted with alcohol. In the aqueous extract 1.34 per cent or 36.81 per cent of the nitrogen of the whole pollen was obtained, the highest extracted by the solvents used. The aqueous extract

TABLE 1.—*Nitrogen content* of mais pollen grains.*

	Per cent
Whole pollen	3.64
Aqueous extract	1.34
Aqueous extract albumin ppt.	0.21
Aqueous filtrate	0.84
Alcoholic extract	0.026
Alkali extract (0.2 per cent KOH)	0.37
Alkali extract ppt.	0.0027
Alkali filtrate	0.32
Residual nitrogen	1.9
Total nitrogen	3.68

* The values given are all calculated on the basis of the original desiccator-dried, free-fat pollen used in the determination. The experiment was repeated seven times, and the results closely checked to each other as well as to Moore's. (7)

contained a coagulable substance, albumin, weighing 0.1104 gram, or 2.76 per cent. This albumin precipitate contained 0.21 per cent nitrogen, while the filtrate contained 0.84 per cent.

With the use of dilute aqueous alkali (0.2 per cent KOH) the nitrogen of the extract obtained was 0.37 per cent or 1.01 per cent of the nitrogen content of the whole pollen. The alkali extract also contained a coagulable precipitate, glutelin, weighing 0.129 gram or 0.32 per cent. The glutelin precipitate contained 0.0027 per cent nitrogen, while the filtrate contained 0.32 per cent nitrogen. The results obtained above compare closely with those of the pollens of two grass species, orchard and timothy, obtained by Moore.(7)

The foregoing data indicate that the nitrogen extractable by the solvents used appeared in the aqueous menstruum. This means that a large amount of nitrogenous constituent consisting of protein and perhaps nonprotein nitrogen was extracted by the aqueous menstruum.

The pollen residue left after exhaustive extractions with the solvents used was found still containing 1.9 per cent or 52.2 per cent of the nitrogen content of the whole pollen. This is about one-half of the nitrogen originally present in the pollen.

EXTRACTION OF NITROGEN FROM OTHER POLLENS USING COCA'S SOLVENT(1)

Morphological data.—The brief morphological data on talahib, corn, urai, and sunflower were given in a previous report by Laserna, et al.(5) Similar data on the pollens of foxtail millet, Natal grass, Java grass and makahiya are presented here to help determine which of these plants have small-sized pollens. These data afford the reader an opportunity to study their shape, structure and outstanding characteristics. (Plates 1 to 4)

The average size of the pollen grain of foxtail millet is 32.17 to 33.28 micra; Java grass pollen, 27.72 to 29.12 micra; and Natal grass pollen, 32.72 to 35.36 micra. Each single circular pore of foxtail millet pollen is 2.08 micra; while that of the Java grass pollen, as well as that of the Natal grass pollen, measures 2.29 micra. In shape and texture, all these pollens are spheroidal and granular.

The makahiya of the *Mimosa* group is very abundant. The shape of the compound pollen varies and the texture is smooth; but the size is small, 20.4 micra in its equatorial diameter. The individual pollen grains are much smaller, from 7.69 to 7.88 micra, and all fused together in groups of 4.

The average size of each type of these newly studied pollen grains is more or less the average size of the ones cited by Wodehouse(10) to cause allergy and also falls within Erdtman's classification(2) from very small (as in the case of the individual pollen of makahiya) to the medium-sized (as found in the three grass pollens).

Procedure and results.—The pollen grains of sunflower, urai, foxtail millet, Java grass, Natal grass and makahiya were collected from specimens found abundant around the U. P. campus in Quezon City and in other areas in and around Manila. Each type of pollen grain was collected as described in a previous report.(6)

The nitrogen content of the whole pollen of each of these plants was determined and the nitrogen from the pollen extracts, mais included, was obtained for routine use essentially in the manner also described in said report.((6) However, the pollen extracts were prepared according to the amount available from each pollen species, that is, one, three, four, and eight grams. After determination of the nitrogen content of the pollen extracts, they were passed through Berkefeld filter and their nitrogen content determined again. These sterile extracts were stored for several months and retested for nitrogen content to determine their keeping quality.

Data on the nitrogen determination of each type of whole pollen and of the extracts before and after filtration through Berkefeld are shown in Table 2. The nitrogen values varied

TABLE 2.—*Nitrogen content of various types of pollen grains and of their extracts.*

Local and scientific name	Nitrogen content of whole pollen	Sample used	Coca's solvent	Aliquot used	Nitrogen content		
					Before filtration through Berkefeld	After filtration through Berkefeld	Recovery
	Per cent	*Grams*	*cc*	*cc*	*Per cent*	*Per cent*	*Per cent*
Mais (*Zea mays* Linn.)	3.64	8	100	0.1	1.10	1.09	99.09
Foxtail millet (*Pennisetum polystachyon* (Linn.) Schultz	4.51	4	100	0.2	1.36	1.31	96.32
Java grass (*Polytrias praemorsa* (Nees) Hack.)	3.61	4	100	0.2	1.28	1.28	100.00
Natal grass (*Rhynchelytrum repens* (Willd.) C. E. Hubb.)	4.39	4	100	0.2	1.15	1.12	97.39
Talahib (*Saccharum spontaneum* Linn. Subsp. *indicum* Hack.)	3.93	3	100	0.2	1.56	1.55	99.35
Urai (*Amaranthus spinosus* Linn.)	4.43	4	100	0.2	1.21	1.18	97.52
Makahiya (*Mimosa pudica* Linn.)	4.31	3	100	0.5	0.94	0.93	98.93
Sunflower (*Helianthus annuus* Linn.)	4.62	1	50	0.5	1.40	1.40	100.00

irregularly on account of the factors affecting plant growth. These include soil condition, age, environment, and exposure to sunshine. Table 3 shows the nitrogen from the extracts after filtration through Berkefeld and the rate of nitrogen loss in the sterile extracts when kept at room temperature from 4 to 13 months.

When tested clinically as causative agents to allergenic conditions, five of the extracts gave positive reactions.[1] These are mais, urai, talahib,(6) foxtail millet, and Java grass.

TABLE 3.—*Loss of nitrogen in extracts after storage at room temperature.*

Local and Scientific name	Length of storage	Nitrogen Content of Extract			
		After Berkefeld filtration	After storage	Lost on storage	
	Months	*Per cent*	*Per cent*	*Per cent*	*mgm/cc*
Mais (*Zea mays* Linn.)	8	1.09	1.05	0.04	0.004
Foxtail millet [*Pennisetum polystachyon* (Linn.) Schultz]	4	1.31	1.29	0.02	0.002
Java grass [*Polytrias praemorsa* (Nees) Hack.]	5	1.28	1.26	0.02	0.002
Natal grass [*Rhynchelytrum repens* (Willd.) C. E. Hubb.]	4	1.12	1.10	0.02	0.002
Talahib (*Saccharum spontaneum* Linn. subsp. *indicum* Hack.)	13	1.55	1.49	0.06	0.006
Urai (*Amaranthus spinosus* Linn.)	4	1.18	1.16	0.02	0.002
Makahiya (*Mimosa pudica* Linn.)	6	0.93	0.91	0.02	0.003
Sunflower (*Helianthus annuus* Linn.)	7	1.40	1.37	0.03	0.003

DISCUSSION

As shown in Table 2, while the amount of pollen was increased, the percentage of nitrogen extracted by Coca's solvent(1) exhibited some descending change, with exceptionally big decrease at 8 per cent proportion as shown on the nitrogen content of the extracts. From each individual proportion of sample used, the highest percentage of nitrogen extracted by the solvent was shown at the 2 to 3 per cent proportion. Evidence is presented which indicates that not all the amount of nitrogen was extracted by Coca's solvent from each of the total nitrogen of the whole pollen. Only about one-fourth to less than one-half, that is, 26 to 40 per cent nitrogen was extracted. This can be explained by the fact that, in the process of extraction, heat and shaking were not employed to avoid denaturation of the protein.

[1] The positive clinical test of talahib extract, which was indicated in our previous report, was confirmed by Dr. Arturo Rotor, associate professor and director of postgraduate school of the College of Medicine, University of the Philippines, when he carried out the clinical test of the extracts.

Filtration through Berkefeld filter did not introduce serious errors. As shown in Table 2 also, almost all the nitrogen present from each extract was recovered. The fluctuation of results must be due most probably to the humidity formed inside the receiving filtering flask during autoclave sterilization process.

The nitrogen content of the sterile extract, that is, the extract after filtration through Berkefeld, and the nitrogen content of the extracts kept at room temperature from 4 to 13 months, show an average rate of loss from 0.002 to 0.006 mg per cc (Table 3) or 0.0005 mgm per cc average each month. Since the nitrogen content of the pollen extracts, as basis for allergenic activity, is 0.001 mgm per unit,(8) the detectable loss of nitrogen as shown from our experiment is quite appreciable. It is believed that the keeping quality of the prepared extracts may be improved by the lyophilization process. Drying of the extracts by vacuum deep-freezing, however, is to be preferred because fresh dilutions can be made frequently when needed with little danger of appreciable loss in potency.

SUMMARY AND CONCLUSION

1. Eight local species of abundant air-borne pollen grains, five of which represent the grass group and three the miscellaneous group, were studied. The grass group consisted of mais (*Zea mays* Linn.), talahib (*Saccharum spontaneum* Linn. subsp. *indicum* Hack.), Natal grass [*Rhynchelytrum repens* (Willd.) C. E. Hubb.], foxtail millet [*Pennisetum polystachyon* (Linn.) Schultz], and Java grass [*Polytrias praemorsa* (Nées) Hack.]. The miscellaneous group was composed of the sunflower (*Helianthus annuus* Linn.), urai (*Amaranthus spinosus* Linn.) and makahiya (*Mimosa pudica* Linn.).

2. A morphological study of Natal grass, foxtail millet, Java grass and makahiya was included. These species were not previously cited to cause allergy, locally or abroad.

3. The total nitrogen from the whole pollen of each type of pollen grain and nitrogen content of each extract preparation therefrom were determined. The results showed that the nitrogen values vary irregularly. The percentage of nitrogen of the different types of pollen grains extracted from the whole pollen by Coca's solvent(1) ranges from more than one-fourth to approximately one-half of the nitrogen present in the whole pollen.

4. The average rate of loss of nitrogen in each of the extracts prepared and stored at room temperature (4 to 13 months' interval), was 0.002 to 0.006 mgm nitrogen per 1 cc (Table 3), or an average of 0.0005 mgm nitrogen per cc each month.

5. From the eight pollen extract preparations studied, five gave positive reactions clinically; namely, mais, urai, talahib, foxtail millet, and Java grass. The first two were cited by Wodehouse(11) to cause allergy and were confirmed by Dr. Rotor's test on local material. The last three are reported for the first time as positive clinically.

ACKNOWLEDGMENT

Thanks are due to Dr. Maria Pastrana-Castrence, of the botany department, University of the Philippines, for advice on pollen collection; and to Mr. Demetrio Mendoza, of the National Museum, for identifying the specimens.

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ILLUSTRATIONS

[Photomicrographs by Cleofaldo S. Angbengco]

PLATE 1

FIG. 1. Inflorescence of foxtail millet [*Pennisetum polystachyon* (Linn.) Schultz].
2. Photomicrograph of pollen grain. × 540.
3. Diagrammatic sketch of pollen grain.

PLATE 2

FIG. 1. Inflorescence of Java Grass [*Polytrias praemorsa* (Nées) Hack.].
2. Photomicrograph of pollen grain. × 565.
3. Diagrammatic sketch of pollen grain.

PLATE 3

FIG. 1. Inflorescence of Natal grass [*Rhynchelytrum* repens (Willd.) C. E. Hubb.]
2. Photomicrograph of pollen grain. × 565.
3. Diagrammatic sketch of pollen grain.

PLATE 4

FIG. 1. Inflorescence of makahiya (*Mimosa pudica* Linn.).
2. Photomicrograph of compound pollen grain. × 621.
3. Diagrammatic sketch of compound pollen grain.

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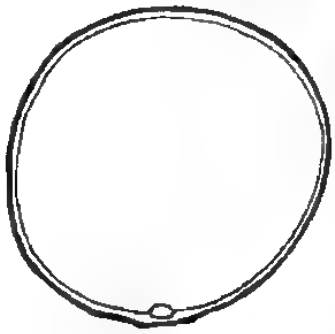

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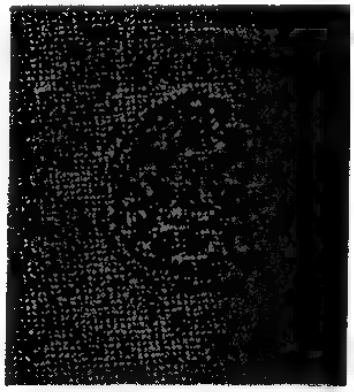

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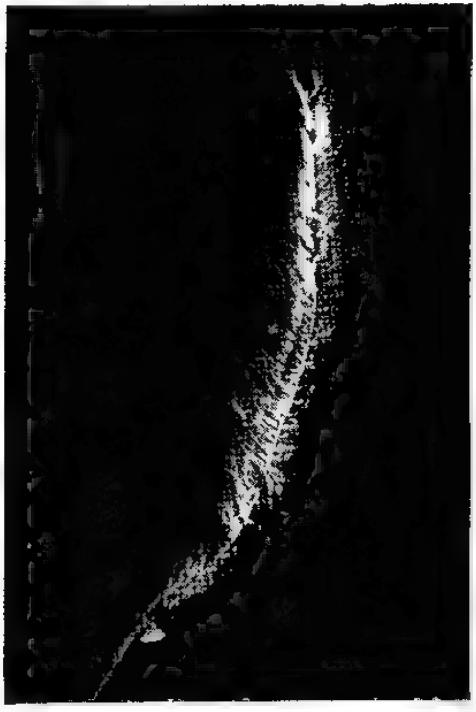

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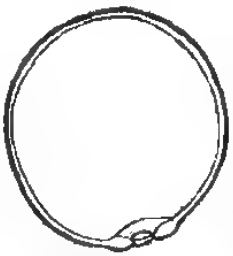

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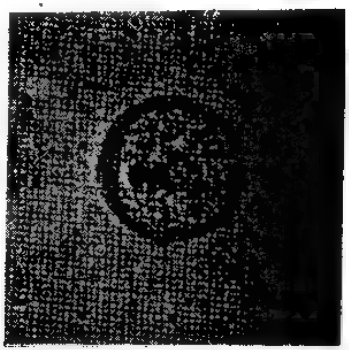

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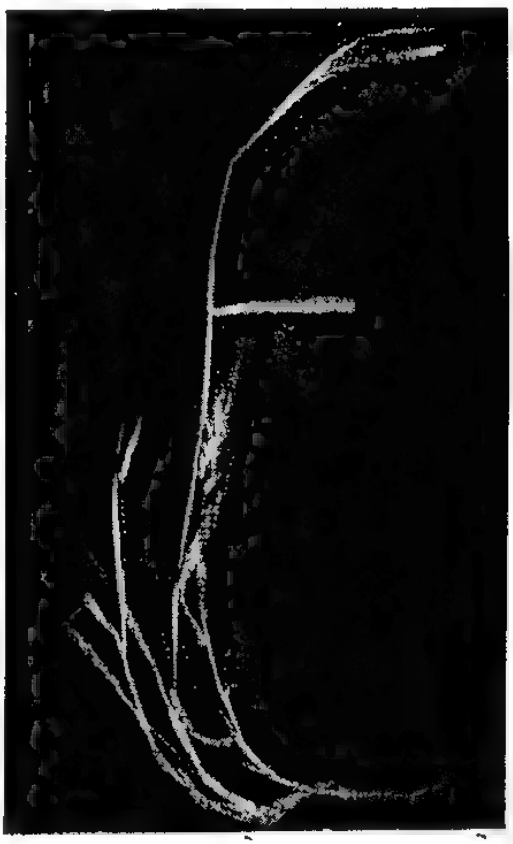

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PLATE 2.

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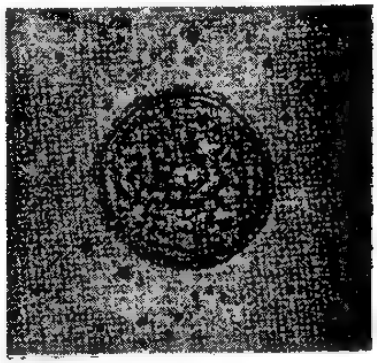

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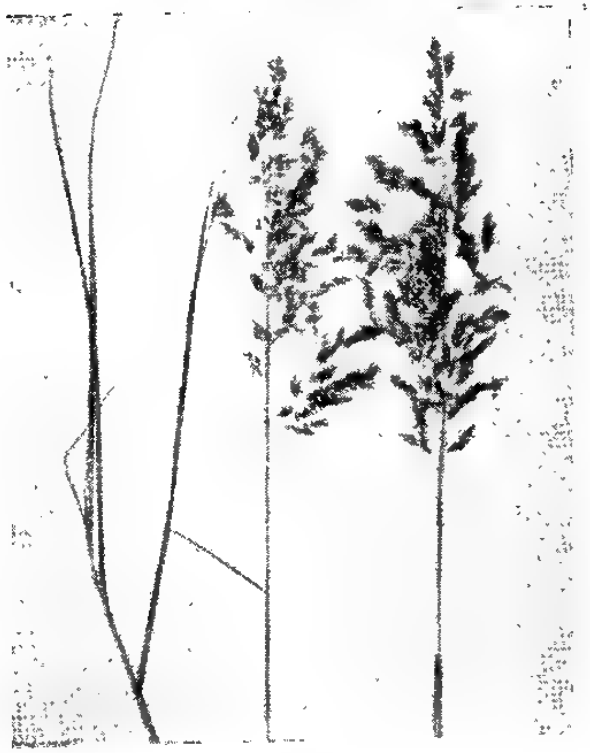

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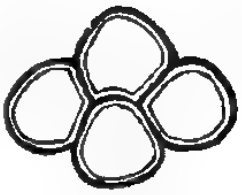

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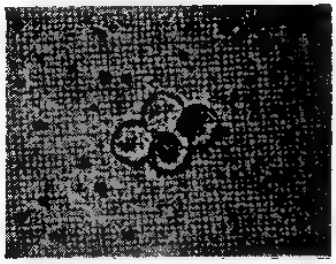

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PLATE 4.

NOTES ON PHILIPPINE MOSQUITOES, XXII
THE AXIL-BREEDING SPECIES

By F. E. Baisas, L. F. L. Bañez, and
Nonette Leuenberger

Institute of Malariology, Tala, Rizal Province, Philippines

Studies by Cabrera and Tubangui(3) and subsequently by Rozeboom and Cabrera(8) have shown that the principal vector of filariasis in Sorsogon Province is an axil-breeding mosquito, *Aedes* (*Finlaya*) *poecilus* (Theobald) 1903.[1] Owing to the presence of numerous abaca in that province, the axils of which harbor *poecilus*, this plant has generally been taken as the index of filariasis in our country. How true and to what extent this assumption might be, the Institute of Malariology tried to determine by means of direct observation on mosquitoes and filariasis in that region.

Abaca (*Musa textilis* Née) is restricted in distribution to Philippine localities with fair distribution of rains throughout the year. Although it is apparently the main source of *poecilus* in Sorsogon Province, there are several other axiled plants to consider. Besides abaca the following were, therefore, included in the investigations:

Anahaw [*Livistona rotundifolia* (Lam.) Mert var. *luzonensis* Becc.]
Banana "saba" [*Musa sapientum compressa* (Blanco) Teodoro]
Biga [*Alocasia macrorrhiza* (Linn.) Schott]
Gabi [*Colocasia esculentum* (Linn.) Schott]
Galiang [*Cyrtosperma merkusii* (Hassk.) Schott]
Nipa (*Nypa fruticans*) Wurmb.
Pandan "bankoang" (*Pandanus simplex* Merr.)
Various small gabiliko ornamentals and wild plants.

After several trial collections of mosquito larvæ and pupæ from axils of all these plants, it was decided to restrict the observations to axils only of abaca, banana, biga, gabi, and pandan. *Aedes amesii* (Ludlow) 1903, a harmless species so far as known at present, seemed to be the only mosquito that

[1] The scientific names given in this paper are according to the latest revision in "A synoptic catalog of the mosquitoes of the world (Diptera: Culicidæ)," by Alan Stone, Kenneth L. Knight, and Hellee Starcke. The Thomas Say Foundation 6 (1959) 358 pp.

bred in the numerous nipa palms growing all along the salt water seacoasts and swamps of Sorsogon Province; while breeding of *poecilus* in anahaw, galiang, and gabilike plants was negligible.

Some 100 abaca plants and an equal number of banana (saba) distributed in four different areas (100 in each area), 60 biga (15 in each area), 100 gabi (25 in each area), and 40 pandan (10 in each area) were examined monthly. The study areas selected were those in which the houses had not been sprayed with insecticide as part of the nation-wide malaria eradication project. Malaria was nonexistent or nearly so in these areas, but filariasis was quite prevalent, over 10 per cent of the population being positive for microfilaria larvæ (Baisas, 1957).

COLLECTION PROCEDURE

To determine the extent of selective breeding taking place among the different mosquitoes and to find out breeding densities in an axil and in a plant, the collections were at first made axil by axil and plant by plant. The entire contents of each axil was pipetted into a white enamel dipper. The axil was then flushed again with some of the water. The operation was repeated two or three times to insure collection of all larvæ and pupæ that might be in the axil. The larvæ and pupæ were carefully counted and recorded. The specimens from each axil were placed in a small vial, which was corked tightly (the cork held secure by adhesive plaster) and labelled accordingly. Each plant was then assigned as many vials as there were axils with breeding. Collections from 25 to 50 plants were packed in a carton box and sent to the Institute of Malariology, in Tala, Rizal Province.

When it had become established that an axil or a plant harbored more than one species of mosquitoes, and enough data concerning breeding densities had accumulated, the collections from any number of plants of one kind were placed together in one container and sent to Tala alive or preserved as needed. The records in such cases also showed the findings in each axil and in each plant, but the number of larvæ and pupæ was not indicated because they were not counted to save time.

To provide some measure of comparison with axiled plants in other parts of the Philippines, the entomological team at Kidapawan, Cotabato Province, Mindanao, as well as the team

at Clark Air Force Base, Pampanga Province, Central Luzon, were requested to make monthly collections of larvæ and pupæ from whatever axiled plants present in sufficient numbers in their respective areas.[2] Abaca, banana (saba), and gabi were available in the Kidapawan area, but at Clark Air Force Base only three kinds of bananas were present in good numbers. These were the cultivated variety, the saba; a semi-wild variety, the butuan [*Musa errans* (Blanco) Teodoro var. *botoan* Teodoro]; and a truly wild variety which the Negritoes called *amucao*. The abaca plants at Kidapawan, on the other hand, were only over a year old; they represented new attempts to re-establish the luxuriant abaca plantations that were completely destroyed by mosaic only two or three years earlier.

The collection technique, recording, etc., employed at Kidapawan and at Clark were the same as those in Sorsogon. But specimens in Kidapawan were preserved immediately after collection and sent to the Institute by ordinary surface mail. Those from Clark were taken to Manila, either alive or preserved, by U. S. Air Force bus.

Contrasts in climatic conditions in these three areas provided a most interesting aspect in relation to the investigations. Clark Air Force Base, just like the rest of Central Luzon, has Type I climate, the main features of which are two sharply defined seasons: dry in November to April, but sometimes prolonged up to May or June, and very wet (typhoon season) during the rest of the year. Sorsogon has Type II climate characterized mainly by rains at all seasons. Kidapawan, in Central Mindanao, has the so-called Type IV climate, which has no pronounced maximum rain period and no dry season. These three types of climate were reflected in the breeding densities.

Trial collections were also made in Tala, Rizal Province, and in San Pablo City, both in Southwestern Luzon.

Axils of bananas (saba), gabi, and pineapple in Tala were investigated in June, July, August, and September, 1957, but breeding was so scarce that the observations were altogether suspended. Out of a total of 338 banana plants, having 1,437

[2] The entomological team at Kidapawan had for its basic assignment the observation of mosquito behavior (specially *flavirostris*) in houses treated with insecticide; while the team at Clark Air Base was assisting the U.S. Air Force entomologist in the study of mosquito fauna in that place.

axils, three hundred seventy-one (371) axils, or 25.12 per cent, had no water; 1,058, or 73.62 per cent, had water but without breeding; and only 8, or 1.26 per cent had breeding. Nine larvæ were collected, consisting of 5 *Aedes albopictus* and 4 *Aedes flavipennis*. Every positive axil had only one larva, except one which had one third-instar *albopictus* and one fourth-instar *flavipennis*.

Three hundred twenty-four (324) pineapple plants were also examined. Each plant had usually over a dozen axils, but almost without exception only one (very rarely two) center axil retained water even during the rainy season. The axils containing no water or no breeding were not recorded in order to save time. Fifteen axils that were positive for mosquito breeding gave a total of 22 *albopictus* larvæ and 9 larvæ of *Malaya genurostris*.

Two hundred fifty-eight (258) axils of 75 gabi plants were similarly examined. None whatsoever had mosquito breeding, although 223, or 86.43 per cent, of them had water and only 35, or 13.57 per cent, had no water.

Over 100 banana plants of various species were examined in San Pablo City during two separate visits. Only one larva of *flavipennis* and one larva of *genurostris* were collected.

RESULTS

FINDINGS IN SORSOGON PROVINCE

The following species of mosquitoes were found breeding in axils of different plants in Sorsogon Province: (*1*) *Aedes* (*Stegomyia*) *albopictus* (Skuse) 1894, (*2*) *Aedes* (*Skusea*) *annesii* (Ludlow) 1903, (*3*) *Aedes* (*Finlaya*) *ananæ* Knight and Laffoon, 1946, (*4*) *Aedes* (*Finlaya*) *flavipennis* (Giles) 1904, (*5*) *Aedes* (*Finlaya*) *medleri* Knight and Laffoon, 1946, (*6*) *Aedes* (*Stegomyia*) *meronephada* (Dyar and Shannon) 1925, (*7*) *Aedes* (*Finlaya*) sp. nov., (*8*) *Aedes* (*Finlaya*) *poecilus* (Theobald) 1903, (*9*) *Armigeres* (*Armigeres*) *baisasi* Stone and Thurman, 1958, (*10*) *Culex* (*Culiciomyia*) *nigropunctatus* Edwards, 1926, (*11*) *Culex* (*Culex*) *quinquefasciatus* Say, 1823, (*12*) *Culex* (*Lophoceraomyia*) sp., (*13*) *Ficalbia* (*Ravenalites*) *deguzmanæ* Mattingly, 1957, (*14*) *Malaya genurostris* Leicester, 1908, (*15*) *Topomyia* spp., (*16*) *Toxorhynchites* sp., (*17*) *Tripteroides* (*Tripteroides*) *dyari* Bohart and Farner, 1944, (*18*) *Zeugnomyia* sp.

Breeding in abaca and banana axils.—The highest percentage of axils with breeding in abaca was in October (60.9 per cent) during which the highest breeding densities of *ananæ* (13.2), of *meronephada* (2.48), and of all species taken together (17.52) also occurred. A secondary peak of breeding for *ananæ* was registered in April (11.65) and May (10.43), a phenomenon, which, in the case of *flavirostris* and other ground-water breeding species, indicates a secondary peak of rainfall. Usually heavy breeding follows a series of heavy rains; more often after the regular rainy season.

Among bananas, the greatest number of axils with breeding was in September (57.35 per cent) correlated with the highest breeding density of *poecilus* (17.24) as well as with the peak of density for all species (19.22). In contrast with those in abaca, the breeding densities of *ananæ* and *meronephada* were consistently lower in bananas month by month: the peak of the density of *ananæ* being only 0.48 (July), and of *meronephada*, 0.51 (January and March). On the other hand, *poecilus* was consistently higher in larval and pupal densities in bananas than in abaca month by month.

The predominance of *poecilus* over *ananæ* or any other species breeding in axils of bananas is similarly marked. Out of 44,587 larvæ and 1,589 pupæ, 35,888 or 80.49 per cent larvæ and 1,193 or 75.08 per cent pupæ were *poecilus*. A poor second was *flavipensis*, with 4,295 or 9.63 per cent larvæ and 195 or 12.27 per cent pupæ. Of *ananæ* there were only 1,796 or 4.03 per cent larvæ and 38 or 2.59 per cent pupæ; and *meronephada*, 2,049 or 4.59 per cent larvæ and 148 or 9.31 per cent pupæ.

To *ananæ* was credited 29,262 or 53.93 per cent larvæ and 527 or 36.42 per cent pupæ out of a total collection of 54,285 larvæ and 1,447 pupæ from abaca. *Meronephada* and *poecilus* were nearly equal, but either was only about half as many as *ananæ;* 11,478 or 21.14 per cent larvæ and 516 or 35.66 per cent pupæ were *meronephada;* 12,243 or 22.55 per cent larvæ and 354 or 24.39 per cent pupæ were *poecilus.*

However, there were individual abaca plants which had more *poecilus* larvæ than *ananæ* larvæ, just as there were individual bananas with more *ananæ* and *poecilus.*

Based on collections made axil by axil and plant by plant, Table 1 shows the different axils of 150 abaca plants and 165 banana plants with the corresponding numbers and percentages of *poecilus* larvæ and pupæ.

TABLE 1.—*Number and percentage of poecilus larvæ and pupæ found in different axils.*

Axil number (from lowest to upward)	150 Abaca plants						165 Banana plants					
	Larvæ		Pupæ				Larvæ		Pupæ			
	No.	Per cent	♂♂	♀♀	No.	Per cent	No.	Per cent	♂♂	♀♀	No.	Per cent
1	100	10.77					269	9.84	11	4	15	13.51
2	175	16.70	2		2	8.69	380	13.99	5	6	11	9.91
3	166	17.88	1	1	2	8.69	497	18.15	12	15	27	24.32
4	224	24.14	5	5	10	43.48	530	19.35	8	9	17	15.31
5	152	16.39		4	4	17.38	526	19.33	12	7	19	17.20
6	93	10.02	3		3	13.04	345	12.56	4	6	10	9.00
7	15	1.42		1	1	4.36	157	5.73		6	11	9.91
8	3	0.68		1	1	4.36	32	0.99	1		1	0.84
9	0						2	0.06				
Total	928	100	11	12	23	100	2,738	100	53	58	111	100

Larvæ of other species, but no *poecilus*, were found in axil No. 9 of some abaca plants.

As the great majority of the plants had only 5 or 6 axils each, it seems reasonable to assume that *poecilus* prefers breeding mostly in the middle axils: axil No. 4 among abaca plants and No. 4 or No. 5 among banana plants.

The average *poecilus* larvæ per plant in these 150 abaca plants was 6.187, but the average in the 165 bananas was 16.594 or nearly three times as many as in abaca. Average pupæ 0.153 and 0.673, respectively.

If these *poecilus* larvæ are classified by the instars, the number and percentages, inclusive of the pupæ, will be as shown in Table 2.

TABLE 2.—*Number and percentage of larval instars and pupæ of poecilus.*

Larval instars and pupæ	150 Abaca plants		165 Banana plants	
	Larvæ		Larvæ	
	Total	Per cent	Total	Per cent
First	303	38.17	783	27.47
Second	276	29.02	1,092	38.33
Third	162	17.07	516	18.11
Fourth	127	13.35	347	12.18
Pupæ	23	2.93	111	3.91
Total	951	100.00	2,849	100.00

Measurements of the water contained in 100 abaca axils and 100 banana axils showed a range of from 15 to 33 cc in abaca axils, or an average of 23.95 cc; from 20 to 80 cc in banana axils, or an average of 36.23 cc. In either plant, however, 25 cc was found most often, occurring in 18 abaca axils and in

26 banana axils. Next in frequency was 20 cc for abaca, and 30 cc for banana, 17 axils of either plant having this capacity. The minimum (15 cc) and the maximum (33 cc) for abaca were met only once each; while the minimum for banana (20 cc) was registered by three axils, but the maximum (80 cc), only by one axil. Two axils had the second highest capacity of 70 cc each. The average capacity (36.23 cc) of a banana axil exceeds the average capacity of an abaca axil (23.95 cc) by some 12 cc, and this, together with the greater number of axils bananas usually have, would seem to explain, at least in part, why banana has higher breeding density than abaca.

Breeding in biga axils.—Biga is a wild plant that is now grown in Manila and suburbs in yards and gardens. It thrives in nature in wet places along streams. Our monthly observations of breeding in this plant suffered repeated setbacks because of periodic cuttings by landowers. *Poecilus* and other *Aedes* species found breeding in abaca and banana axils also breed in axils of biga. *Aedes medleri* seems to prefer axils of biga to axils of other plants; but in certain months the water in biga axils becomes "soapy," which does not seem to aid the breeding of *Aedes*. On the other hand, this condition evidently favors the breeding of *Armigeres* to such an extent that all other species seems to be crowded out completely.

Elsewhere, as in Tala, in Laguna Province, and in the Sierra Madre, *Aedes flavipennis* is the predominant, and sometimes the only, species found breeding in biga axils.

Breeding in gabi and gabilike plant axils.—With fewer and smaller axils and the whole plant much smaller than biga, gabi has a relatively short existence because it is planted and harvested in about three months. There are not many gabi plants in Sorsogon. Only a few *poecilus* larvæ and pupæ were found in this plant. More than 90 per cent of the total collections from gabi axils were *Malaya genurostris*, a harmless non-blood-sucking mosquito; *poecilus* was slightly over 3 per cent.

The capacity of gabi axils, based on 100 measurements, varied from 13 to 27 cc, the average being 14.97 cc.

Various kinds of ornamental and wild gabilike plants were also investigated for breeding of mosquitoes. Although *poecilus* larvæ were found in a few of them, they are believed to be of no real importance in connection with filariasis in Sorsogon Province.

of *poecilus* were caught in one house in Barrio Malasila: 64 on January 15, 1959; and 31 on January 29, 1959. The number of *poecilus* caught represented the highest record in the Philippines outside Sorsogon Province. From the same house, 96 *flavirostris* (50 engorged and 46 unfed), 1 blooded *limosus*, 1 blooded *uniformis* and 1 unfed *Aedes* (*Aedimorphus*) *vexans nocturnus* (Theobald) 1903, or a total of 99 mosquitoes, were caught on the night of March 12, 1959. This catch of *flavirostris* was the largest made during one night in a single house in the Philippines, the second highest being 72 (39 blooded and 33 unfed) taken by the WHO team in an all-night collection in an insecticide-sprayed house at Barrio Capirpiran in Isabela Province.

For a better understanding of the feeding preferences of *poecilus*, blood meals from caught wild specimens are now being prepared for precipitin tests abroad.

FINDINGS IN KIDAPAWAN, COTABATO

Before mosaic devastated the abaca plantations in Kidapawan and many other parts of Cotabato Province, one would reasonably assume that there had been numerous *poecilus* in these places, judging from the impressions obtained in Sorsogon Province. Likewise, when abaca declined some three years previously, *poecilus* would logically be expected to concentrate breeding in banana axils, of which there were quite a considerable number in those parts. If *poecilus* were actually present in large numbers when the abaca plants were numerous, there ought to be much higher *poecilus* breeding densities in bananas at Kidapawan at the time of our observations than in Sorsogon. However, such was not the case. The reverse was true. That fact seems to indicate that abaca is not as intimately linked with *poecilus* and filariasis as previously thought. Of course, there are other factors to consider: the climate, other vector mosquitoes which seem to be more often encountered in Mindanao than in Luzon, etc.

Monthly collections from axils of, and densities of breeding in, 50 abaca at Barrio Lamitan and 50 bananas (saba) in the town center of Kidapawan were taken and compared with collections from the same plants in Sorsogon. Fifty gabi plants in Barrio Malasila were also examined monthly for a comparison with similar examinations on 50 gabi plants in Sorsogon Province. The results showed there were fewer species(7)

and lower densities registered in the Kidapawan-Lamitan area. Only *Malaya genurostris* bred with some degree of monthly continuity in gabi axils at Kidapawan, the break occurring in February when the axils became dry. In both Kidapawan and Sorsogon *poecilus* was very scanty in gabi plants, much more so in Kidapawan.

Anahaw, gabi and pandan were also found in the Kidapawan study area, but not in sufficient numbers to meet the requirements of comparative studies.

FINDINGS IN CLARK AIR FORCE BASE

Before the extension of sugar-cane plantings in the 1920's most of the agricultural lands in Pampanga Province were covered with lush growth of grasses (cogon, etc.) with considerable admixture of wild bamboos and wild and semi-wild bananas, a condition now still obtaining in parts of Clark Air Base, Pampanga Province. Cultivated bananas of different kinds are grown to a very limited extent, specially in the surrounding communities. In the Base proper 50 saba and 50 amucao, in Lilly Hill 50 butuan, and at Forest Hill another 50 butuan banana plants were examined monthly.

The results of 12 months' operations showed breeding in the axils of cultivated and wild bananas from October through the month of March of the following year. The species found were predominantly *Aedes poecilus, Aedes flavipennis* and *Malaya genurostris* with a few *Aedes medleri* and *Aedes meronephada*. There was no breeding in the succeeding dry months of April and May as well as in June, when the early seasonal rains had just begun to refill the axils with new water.

The monthly percentages of abaca and banana axils with breeding and the monthly densities of *Aedes poecilus* compared with findings in Sorsogon and Cotabato are shown in Tables 3 and 4, respectively.

DISCUSSION

The relatively heavy rainfall throughout the year in Sorsogon Province is reflected in the high percentage of abaca and banana axils with mosquito breeding (Table 3). No distinct peak, however, was recorded: the highest being in October (60.9 per cent); the lowest, in July (36.43 per cent). But the records for certain other months almost equalled that for October. The highest for bananas was in September (57.35 per cent); the lowest, in April (18.62 per cent). Abaca in Kidapawan registered a peak of 63.51 per cent in December,

TABLE 3.—*Comparative monthly percentages of axils with breeding (abaca and banana: Sorsogon, Cotabato, and Pampanga).*

Year and month	Abaca		Bananas					
			Saba			Amueno	Butuan	
							Clark Air Base	
	Sorsogon	Kidapawan	Sorsogon	Kidapawan	Clark Air Base	Clark Air Base	Forest Hill	Lilly Hill
1957	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
July	36.43	No breeding	45.19					
August	50.84	3.94	39.19	11.57				
September	55.83	10.59	57.35	26.38				
October	60.90	26.13	52.14	37.06	8.53	27.57	45.23	42.29
November	49.73	48.24	35.74	45.91	24.26	36.18	61.03	57.10
December	59.54	63.51	44.80	40.56	13.02	21.84	58.08	41.90
1958								
January	55.57	25.23	51.15	28.48	all dry	8.71	25.53	29.31
February	56.48	19.19	25.80	24.60	9.58	7.34	14.57	24.56
March	57.96	0.22	32.34	2.60	13.86	7.42	13.04	19.90
April	42.87	dry	13.62	0.25	dry	dry	dry	dry
May	56.20	dry	29.20	dry	dry	dry	dry	dry
June	46.67	No breeding	28.63	No breeding	No breeding	No breeding	No breeding	No breeding

TABLE 4.—*Comparative monthly densities of Aedes poecilus.*

Year and month	Larvæ						Pupæ					
	Sorsogon		Kidapawan		Clark Air Base		Sorsogon		Kidapawan		Clark Air Base	
	abaca	saba	abaca	saba	butuan	saba	abaca	banana	abaca	banana	butuan	saba
1957												
July	0.52	12.96					0.04	0.60				
August	2.16	12.65	0.075	0.68			0.02	0.40	0.01	0.099		
September	3.08	17.24	0.130	2.60			0.04	0.68	0.02	0.21		
October	1.25	9.89	0.64	3.58	2.12	0.79	0.01	0.29	0.04	0.24	0.17	0.08
November	6.17	9.22	5.70	6.38	6.98	3.06	0.09	0.15	0.42	0.62	0.28	0.18
December	5.97	9.59	5.35	5.09	9.88	1.28	0.13	0.20	0.10	0.32	0.45	0.06
1958												
January	1.77	9.41	1.77	3.42	6.00	all dry	0.02	0.30	0.05	0.42	0.25	all dry
February	1.76	3.05	0.87	2.72	3.05	n.b.*	0.02	0.06	0.04	0.33	0.05	all dry
March	0.78	5.13	0.007	0.09	1.20	n.b.*	0.01	0.11	0.00	0.05	0.10	all dry
April	1.08	3.65	all dry	0.11	all dry	all dry	0.04	0.34	all dry	all dry	all dry	all dry
May	0.49	7.09	all dry	all dry	all dry	all dry	0.01	0.21	all dry	all dry	all dry	all dry
June	0.19	6.20	n.b.*	n.b.*	n.b.*	n.b.*	n.b.*	0.07				

* No breeding.

but the percentages for the succeeding months dropped rapidly: 0.22 per cent in March; zero (that is, the axils became dry or a few had water but without breeding) in April, May, June and July. Banana axils in Kidapawan reached a peak of 45.91 per cent with breeding in November, but the percentages also dropped rapidly during the next months, becoming zero in May, June and July. In Clark Air Base, the peak was 24.26 per cent (November) for saba, 36.18 per cent for amucao, 61.03 per cent and 57.1 per cent for butuan at Forest and Lily Hills, respectively. Breeding was maintained for six months (October to March, inclusive), becoming absent during the other six months.

Density of *poecilus* breeding (in this case, density means the average number of *poecilus* larvæ or pupæ per plant at any given time): 6.17 (November) for abaca in Sorsogon Province, followed closely by 5.97 (December). The lowest was in June (0.19). (Table 4.) For bananas, the highest was in September, 17.24; followed by 12.96 and 12.55 in July and August, respectively. The lowest was 3.05 in February. In Kidapawan, the highest density for abaca was 5.50 (November) and 5.35 in December. The lowest, besides zero, was 0.007 in March. For bananas, 6.38 in November was the highest density, the next highest being in December (5.09). The lowest, apart from zero, was 0.09 in March.

Potential transmitters of filariasis in the sense that they were found with noninfective microfilaria larvæ, *Aedes ananæ*, *Aedes meronephada* and *Armigeres baisasi*, are other axil-breeding species which should be carefully watched in Sorsogon Province. *Ananæ* breeds heavily at all seasons, while *baisasi* attains very high peak of density (in biga axils) in certain months. *Meronephada* breeds moderately, but seems to be more prone to visit houses than either *ananæ* or *baisasi*. *Aedes flavipennis* also breeds quite heavily (more so than *meronephada*), but its adults are very rarely caught indoors. *Uranotænia tubanguii* and the new form, "near-*ananæ*," are also seldom caught in houses at night or during the day.

SUMMARY

1. Preliminary findings on mosquito breeding in axils of plants in various parts of Sorsogon Province; in Kidapawan, and its barrios of Lamitan and Malasila, Cotabato Province; and at Clark Air Base, in Pampanga Province, are presented.

2. Located as they are in different types of climate, these areas are not strictly comparable, and they were not chosen for comparative purposes. Studies at Clark Air Base were primarily an over-all appraisal of the mosquito fauna; the investigation done in Kidapawan and its barrios was in connection with insecticide-spraying of houses; whereas observations on mosquitoes breeding in plant axils formed only a part of the activities undertaken by the Filaria Pilot Project in Sorsogon Province.

3. The type of climate appears to be the most important factor that determines the density and duration of mosquito breeding in plant axils. Because of the more abundant and more evenly distributed rains in Sorsogon, a good portion of the axils contains water at all seasons and so mosquito breeding continues the year round. This seems to be also the reason why more species breed in plant axils in Sorsogon than in Cotabato or Pampanga: 18 were found in Sorsogon, only 7 in Cotabato, and 5 in Pampanga. The climate in Sorsogon is wet throughout the year with very pronounced maximum rainfall from November to January. Rainfall in Cotabato is more or less evenly distributed throughout the year, but usually the rains during summer are so light that the axils become dry and mosquito-breeding ceases. The definitely dry months of November to April in Pampanga restrict breeding in axils to a greater extent than in Cotabato.

4. The axils of abaca and banana are the most important breeding receptacles of certain mosquitoes, but specially of *Aedes poecilus*, the principal transmitter of filariasis in Sorsogon Province. The saba (*Musa sapientum compressa*) harbors, as a general rule, more *poecilus* than abaca when considered axil by axil or plant by plant. A close relative of *poecilus*, *Aedes ananæ* breeds more abundantly than *poecilus* in the axils of abaca. However, because of the enormous predominance of abaca in Sorsogon, the total *poecilus* output necessarily comes more from abaca than from bananas.

5. Other kinds of cultivated bananas in the observation areas are relatively few. Moreover, their axils do not retain water because of their loose attachment. Wild and semiwild bananas outnumber saba at Clark Air Base; and these are the main sources of *poecilus* in that place. Wild bananas abound in many newly opened agricultural lands in the Philippines, where they may become sources of trouble in relation to filariasis.

6. Though biga, pandan, anahaw, galiang, and other gabi-like wild and ornamental plants harbor *poecilus*, they may be considered unimportant unless present in large numbers. Nipa, which abounds along salt-water seacoasts and swamps, seems to afford nursery only to the apparently harmless *Aedes amesii*.

7. For more than one year, the collections from plant axils were done and identified separately axil by axil and plant by plant. This was to determine whether particular species bred only in particular axils or in particular plants. While certain species are evidently strict in their choice of axils (for instance, *Uranotaenia tubanguii* and an undescribed form very close to *ananæ* breed only in axils of *Pandanus* sp.; and *Aedes amesii*, only in axils of nipa), *poecilus* breeds in almost all kinds of axils, although highly preferring the axils of abaca and banana (saba).

8. Normally, there were more first-instar larvæ than second-instar; more second-instar than third; and more third-instar than fourth. This may not be the case when the collection comes from only one or a few plants, but when a large number of plants are investigated and the total collections analyzed as a whole the proportion just mentioned holds. It seems reasonable to assume that the percentage of pupæ in relation to the first-instar larvæ of each species at the time of collection represents what is actually happening in nature. Hence, the figures given for abaca have only about 6 per cent reaching the pupal stage while those for bananas have 14 per cent.

9. Once a week, for more than one year, all-night catching of *poecilus* was done hour-by-hour in a small house highly frequented by this mosquito in a barrio of Sorsogon. The results indicate the highest numbers entered around midnight. There was a slight resurgence from 5:00 to 6:00 a.m., but this might represent late comers, although some of them might have missed being caught earlier.

10. Very few other species were caught with *poecilus* in that house; *Anopheles flavirostris*, the malaria vector in the Philippines, was very poorly represented. The place may appropriately be called a "*poecilus* territory." On the other hand, Kidapawan, Cotabato Province, may be considered a "*flavirostris* territory" because this mosquito is more often caught in these houses and in larger numbers than elsewhere in the Philippines. A house in Barrio Malasila holds the dis-

tinction of having the highest number of *flavirostris* taken in an all-night catching, 96, on March 12, 1959. It also holds the highest record of *poecilus* caught in one night outside Sorsogon Province, 64, on the night of January 15, 1959. But this is much lower than the highest number, 398, caught in Sorsogon in one night, on January 24, 1958.

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SOME SCOLYTIDÆ AND PLATYPODIDÆ (COLEOPTERA) FROM THE ORIENTAL REGION

By F. G. Browne

Through the kindness of Mr. F. C. Francia, of the Forest Products Research Institute, Laguna, I have been able to examine a small but interesting collection of Scolytidæ and Platypodidæ, containing several undescribed species and others not hitherto recorded from the Philippines. In addition to these, I shall discuss in this paper a considerable number of species from Borneo and Malaya. Of particular note are the occurrence of the genus *Acacisis*, formerly known only in southern Australia and New Zealand, in the Malaysian Subregion; the apparently established presence, in the Philippines, of *Ips interstitialis* Eichh., which has long been known in Central America; and a new genus, *Prowebbia*, of the tribe Webbini in Borneo.

SPECIES NEW TO THE PHILIPPINE LIST

Ips interstitialis Eichh. Benguet, Mt. Province, April 15, 1956, *ex* Benguet pine (*Pinus insularis*), F. C. Francia coll.

Xyleborus intermedius Egg. Mt. Maquiling, Laguna, March 30, 1955, *ex* undet. sp. Dipterocarpaceæ, F. C. Francia coll.

Xyleborus macropterus Sch. Mt. Maquiling, Laguna, October 16, 1957, *ex* Dipterocarpaceæ, F. C. Francia coll.

Platypus artesolidus Sch. Basilan, Mindanao, May 5, 1955, F. C. Francia coll.

SPECIES NEW TO THE BORNEAN LIST

Scolytoplatypus bombycinus Brne. Sarawak, Kuching, November 11, 1958, *ex Shorea rugosa* (Dipterocarpaceæ), fallen tree, *F.G.B. 5972.*

Diamerus curvifer Walk. Sarawak, Semengoh, August 22, 1957, in bark of *Artocarpus anisophyllus* (Urticaceæ), cut tree, *F.G.B. 5830.*

Poecilips longior Egg. Sarawak, Semengoh, January 19, 1959, in bark of *Artocarpus anisophyllus* (Urticaceæ), cut tree, *F.G.B. 6055.*

Xyleborus quadricostatus Sch. Sarawak, Kuching, December 5, 1958, in dead branch of *Garcinia* sp. (Guttiferæ), *F.G.B. 6001.*

Xyleborus curvidentis Sch. Sarawak, Semengoh, June 6, 1959, in twig of *Shorea* sp. (Dipterocarpaceæ), cut tree, *F.G.B. 6325.*

Xyleborus vigilans Sch. Sarawak, Kuching, September 9, 1956, *F.G.B. 5474.*

Xyleborus vestitus Sch. Sarawak, Kuching, February 21, 1957, *F.G.B. 5782.*

Xyleborus caolator Brne. Sarawak, Semengoh, January 25, 1957, in log of *Shorea* sp. (Dipterocarpaceæ), *F.G.B. 5753.*

Xyleborus minutus Blandf. Sarawak, Kuching, October 31, 1958, in log of *Shorea* sp. (Dipterocarpaceæ), *F.G.B. 5966.*

Xyleborus circumcisus Samps. Sarawak, Kuching, April 27, 1956, *ex* fallen *Pasania* sp. (Fagaceæ), *F.G.B. 5408.*

Xyleborus trolaki Sch. Sarawak, Kuching, May 9, 1956, *F.G.B. 5454.*

Xyleborus scabrior Sch. Sarawak, Kuching, May 17, 1956, *F.G.B. 5487.*

Xyleborus limatus Sch. Sarawak, Kuching, August 22, 1957, in cut branch of Leguminosæ, L.S.V. Murthy coll., *F.G.B. 5819.*

Xyleborus pumilus Egg. Sarawak, Semengoh, January 9, 1959, in log of *Artocarpus* sp. (Urticaceæ, *F.G.B. 5837.*

Xyleborus perparvus Samps. Sarawak, Kuching, July 15, 1959, *ex Vatica* sp. (Dipterocarpaceæ), *F.G.B. 6349.*

Xyleborus percorthylus Sch. Sarawak, Semengoh, January 9, 1959, in log of *Shorea* sp. (Dipterocarpaceæ), *F.G.B. 6058.*

Notoxyleborus kalshoveni Sch. Sarawak, Semengoh, April 9, 1959, in cut rattan (Palmæ), *F.G.B. 6212.*

Arixyleborus grandis Sch. Sarawak, Kuching, June 23, 1959, in cut branch of *Palaquium* sp. (Sapotaceæ), *F.G.B. 6328.*

Arixyleborus granifer Eichh. Sarawak, Kuching, September 27, 1957, in dying *Koompassia* sp. (Leguminosæ), *F.G.B. 5869.*

Arixyleborus granulifer Egg. Sarawak, Semengoh, January 25, 1957, *F.G.B. 5761.*

Arixyleborus rugosipes Hopk. Sarawak, Semengoh, January 16, 1957, in log of *Shorea beccariana* (Dipterocarpaceæ), *F.G.B. 5747.*

Arixyleborus suturalis Egg. Sarawak, Kuching, November 18, 1958, in log of *Nephelium* sp. (Sapindaceæ), *F.G.B. 5897.*

Cryptoxyleborus simplex Brne. Sarawak, Kuching, July 15, 1959, in small log of *Shorea* sp. (Dipterocarpaceæ), *F.G.B. 6345.*

Webbia cornutus Sch. Sarawak, Kuching, November 11, 1958, in log of *Shorea rugosa* (Dipterocarpaceæ), *F.G.B. 5974.*

Webbia costulatulus Sch. Sarawak, Kuching, November 28, 1958, in cut branch of *Palaquium* sp. (Sapotaceæ), *F.G.B. 5991.*

Platypus pernanulus Sch. Sarawak, Kuching, November 18, 1957, in log of *Nephelium* sp. (Sapindaceæ), *F.G.B. 5901.*

Platypus circulicauda Brne. Sarawak, Simanggang, October 20, 1957, L.P. Zehnder coll., *F.G.B. 5882.*

Platypus subaplanatus Sch. Sarawak, Simanggang, October 20, 1957, L.P. Zehnder coll., *F.G.B. 5883.*

Platypus puerulus Sch. Sarawak, Semengoh, February 18, 1959, in dying *Dialium* sp. (Leguminosæ), *F.G.B. 6142.*

NEW SPECIES OF SCOLYTIDÆ

ACACISIS MALAYANUS sp. nov.

Related to *A. minor* Sch., but smaller, the apex of the pronotum devoid of armature, the elytral striæ on the declivity not

impressed and the interstriæ not convex. One to 1.1 mm long, 1.9 times as long as wide, dark brown, subnited rather densely but not conspicuously clothed with erect, feathered, scalelike hairs. Front flattened, finely punctured. Pronotum 1.3 times as wide as long, widest near base, base weakly angulate at middle, basal angles obtuse, sides feebly and evenly incurved, apex narrow, transverse, unarmed, surface weakly and evenly convex, strongly and evenly punctured, punctures bearing erect, featherlike hairs. Scutellum not visible. Elytra distinctly wider than pronotum and 1.7 times as long, base raised and crenulate, sides subparallel to middle, then only slightly incurved, apex very broadly rounded; disc cylindrical, declivity beginning behind middle, convex: finely and rather indistinctly seriate-punctate, striæ not impressed, their punctures circular, shallow, without hairs, interstriæ flat, smooth, densely, irregularly and very finely punctured, punctures bearing erect, featherlike hairs, 7th interstria with a large, blunt, tuberclelike swelling at apex.

Holotype in the British Museum; a paratype in my collection.

MALAYA: Selangor, Kepong, January 25, 1950, in bark of a small, cut liane, *Fissistigma elegans* (Annonaceæ), *F.G.B. 5225.*

ACACISIS BORNEENSIS sp. nov.

Very closely related to the preceding species, but the elytra without a tuberclelike swelling in either sex, the punctures with scarcely any trace of seria arrangement, and the scalelike hairs stronger.

Oval, convex, black, appendages yellowish; 1.0 to 1.2 mm long, 1.8 times as long as wide. Front planoconvex, subnitid, finely punctured. Pronotum 1.4 times as wide as long, widest at base, base very broadly angulate, sides curved and convergent, apex transverse, surface weakly and evenly convex, smooth, finely and shallowly punctured, sparsely and finely pubescent. Scutellum not visible. Elytra wider than pronotum and nearly 2.0 times as long, base raised and crenulate, sides subparallel to middle, then incurved, apex very broadly, abruptly rounded (especially in male), disc cylindrical, declivity beginning at about middle, convex; entire surface finely and densely punctured, punctures varying in size but a serial arrangement scarcely at all evident, punctures bearing scalelike hairs.

Holotype in the British Museum; paratypes in the British Musuem and in my collection.

SARAWAK: Kuching, June 5, 1959, in bark of *Vatica* sp. (Dipterocarpaceæ), cut tree, *F.G.B. 6317.*

XYLEBORUS DUPLOARMATUS sp. nov.

A robust species, related to *X. sexspinatus* Sch., but stouter, the declivital depression of the elytra distinctly shorter and more abrupt, and the species is easily recognized by the double armature of the interstriæ on the margin of the declivity.

Female.—5.0 mm long, 2.0 times as long as wide, subcylindrical, subnitid, brown. Front irregularly convex, shining, moderately strongly punctured. Eyes of moderate size, not extending on to front. Pronotum 1.2 times as wide as long, widest at base, base weakly sinuate, basal angles subrectangular, sides subparallel in basal third, then curved into broadly rounded apex which is weakly produced at middle and armed with two closely spaced, blunt asperities; surface steeply convex in front, summit situated behind middle, distinct but scarcely raised; anterior slope densely but not very strongly asperate, asperities low and broad, extending to basal third at sides and becoming very dense and granulose on summit, basal area rather densely granulate medianly, moderately strongly punctured towards sides; vestiture of fine, erect hairs on anterior slope and sides. Scutellum oblong, shining. Elytra little wider than pronotum and 1.4 times as long, sides subparallel, very slightly widened to broadly rounded apex, which is not margined, disc cylindrical, declivity beginning at about middle, convex longitudinally but flattened up to 5th interstria; disc moderately strongly punctured, punctures varying in size and with evident serial arrangement towards declivity, interstriæ here broad, flat and less strongly multiseriate punctate, each interstria armed with two strong tubercles on margin of declivity; flattened declivital face with distinct impressed striæ, strial punctures large, circular and shallow, interstriæ, weakly convex, moderately strongly multiseriate punctate and with fine, yellow hairs.

Holotype in the British Museum; another specimen in my collection.

SARAWAK: Kuching, June 23, 1956, in dying tree, Yakup bin Abdul Manan coll., type, *F.G.B. 5534;* same locality and collector, November 8, 1957, in dead tree, *F.G.B. 5886.*

XYLEBORUS CRISTATULUS Sch., m. nov.

Male.—1.9 mm long, 2.3 times as long as wide, cylindrical, subnitid, brown. Front plano-convex, subnitid, finely punctured,

finely and sparsely pubescent. Pronotum as wide as long, base transverse, basal angles obtuse, sides subparallel to apical fourth, apex very broadly rounded, subtransverse medianly; surface weakly and evenly convex, anterior half and sides with scattered fine points bearing erect hairs, basal half shagreened, with moderately large but shallow punctures. Scutellum triangular. Elytra a shade wider than pronotum and 1.4 times as long, sides subparallel to apical third, apex rounded and without a distinct margin, disc cylindrical, declivity beginning at apical third, obliquely convex, somewhat flattened along 1st and 2nd interstriæ; disc moderately finely seriate punctate, striæ not impressed, their punctures separated by spaces about as wide as their diameter, interstriæ flat, smooth, finely uniseriate punctate, punctures almost as numerous as those of striæ, outer interstriæ minutely uniseriate granulate-punctate and bearing rather long, erect hairs; all interstriæ with uniseriate, fine, piliferous granules on declivity.

Specimen in the British Museum.

MALAYA: Selangor, Kepong, September 18, 1949, in wood of dead tree, in association with the female, *F.G.B. 4997*.

XYLEBORUS BELLUS Samps., n. nov.

Subcylindrical, brown, apex of elytra darker; 3.1 mm long, 2.0 times as long as wide. Head deeply concealed below pronotum, front plano-convex, subnitid, moderately finely punctured. Pronotum 1.1 times as long as wide, base weakly sinuate, basal angles subrectangular, sides weakly curved, antero-lateral angles produced forwards and downwards to form broad points separated by a very deep emargination, surface convex in basal half, summit situated at about basal third; anterior slope of disc deeply hollowed, its fundus flat between high lateral convexities; the whole surface densely and rather strongly punctured and finely pubescent. Scutellum concealed. Elytra a shade narrower than pronotum and only 0.9 times as long, sides subparallel to apical third, apex rounded, disc cylindrical, declivity beginning rather abruptly at about middle, convex; disc densely and moderately finely punctured, without trace of serial arrangement, and with a pubescence of fine hairs; declivity densely, finely granulate and bearing more conspicuous hairs especially towards suture.

A specimen in the British Museum.

SARAWAK: Kuching, May 29, 1959, in cut branch of *Vatica* sp. (Dipterocarpaceæ), in association with the female, *F.G.B. 6309*.

STREPTOCRANUS LONGICAUDA sp. nov.

Most closely related to *S. bicuspis* (Egg.) of known species, but larger, and the apical processes of the elytra less strongly upcurved.

Female.—Shining, brown, apices of elytral processes black; 4.0 mm long, 3.9 times as long as wide. Front broad, planoconvex, subnitid, rather densely granulate-punctate below eyes, towards vertex reticulate and moderately strongly punctured, pubescence fine and rather dense. Pronotum nearly 1.4 times as long as wide, widest at about anterior third, base transverse, basal angles broadly rounded, sides straight and subparallel in basal third, then abruptly expanded and weakly curved, apex very broadly rounded when viewed from above but vertically produced downwards and with a very weakly concave margin, surface steeply convex in front, summit situated at about anterior third and not prominent; anterior slope asperate on a smooth ground, asperities elongate and well separated, not reaching sides behind anterior fourth, summit not densely rugose, basal area smooth, rather sparsely, finely and shallowly punctured; pubescence sparse and fine. Scutellum small. Elytra scarcely as wide as pronotum and 1.7 times as long, sides almost straight and convergent from base to apex, apex narrowly rounded between processes, disc cylindro-convex, becoming very obliquely declivous from in front of middle, the declivity flattened but not sulcate between processes, the apical processes forming about one-fourth of entire length of the elytra, not strongly compressed, very slightly upcurved, apex of each process with a small tooth at its upper angle; surface moderately strongly seriate-punctate, striæ not impressed, their punctures deep and separated by spaces about as wide as their diameter, 1st stria curved out on the declivity so that only 1st interstria reaches apex between processes, interstriæ flat, smooth, finely and sparsely uniseriate-punctate, granulate-punctate towards sides, punctures bearing rather long, fine, erect hairs.

Male.—Shining, brown, 3.5 mm long, nearly 3.6 times as long as wide. Head situated far behind anterior margin of pronotum, front subnitid, densely and moderately strongly punctured, pubescence fine and rather dense. Eyes of moderate size. Pronotum 1.7 times as long as wide, base transverse, basal angles subrectangular, sides more or less sinuate, basal half cylindrical, summit formed by a triangular prominence at middle, in front of this the surface broadly and deeply sulcate, sulcus bounded in front by an acute edge, the middle of which

is deeply emarginate, below the edge the pronotum steeply produced downwards and slightly backwards with a broadly concave lower margin; basal area and sides smooth, with scattered, moderately fine punctures bearing long erect hairs, anterior sulcus polished and very sparsely punctured. Scutellum very small. Elytra barely 1.1 times as long as pronotum, of the same general form as in female, but interstrial punctures larger, apical processes shorter, relatively stouter, and without a tooth at upper apical angle.

Holotype (female) and allotype (male) in the British Museum; another female in my collection.

MALAYA: Kepong, June 26, 1946, in fallen *Castanopsis sumatrana* (Fagaceæ), *F.G.B. 5346*, types.

SARAWAK: Kuching, June 26, 1956, in dying, poisoned tree, Yakup bin Abdul Manan coll., *F.G.B. 5553*.

ARIXYLEBORUS RUGOSIPES Hopk., m. nov.

Cylindrical, brown, 1.6 mm long, 3.0 times as long as wide. Head not concealed from above by pronotum, the front planoconvex, transversely depressed above mouth, smooth, shining, subimpunctate. Eyes small and narrow. Pronotum 1.55 times as long as wide, widest in apical third, the base transverse, basal angles rounded, sides constricted in basal third, then weakly curved, apex broadly rounded and unarmed, surface cylindrical, weakly transversely depressed at middle and feebly declivous only at extreme apex, smooth, shining, subimpunctate and subglabrous. Scutellum rounded. Elytra scarcely as wide as pronotum and only 0.9 times as long, similar to elytra of female but more weakly sculptured.

A specimen in the British Museum.

MALAYA: Selangor, Banting, April 16, 1949, bred, with the females, from sawn timber of *Shorea uliginosa* (Dipterocarpaceæ), *F.G.B. 4782*.

ARIXYLEBORUS SUTURALIS Eggers, m. nov.

Male.—Cylindrical, subnitid, dark brown, 1.1 to 1.2 mm long, 2.3 times as long as wide. Head concealed from above by pronotum, front convex, subnitid, finely punctured, eyes moderately large, emarginate. Pronotum 1.07 times as long as wide, base transverse, basal angles subrectangular, sides subparallel to apical third, apex rather broadly rounded, surface weakly and evenly convex, anterior half densely granulate-asperate, basal half reticulate, moderately finely and evenly punctured; vestiture of sparse, fine, erect hairs. Scutellum

distinct, semicircular. Elytra as wide as pronotum and 1.15 times as long, sides parallel to apical third, apex rounded, disc cylindrical, declivity beginning at about apical third, convex, finely margined up to seventh interstria; disc strongly seriate punctate, on basal half the striæ not impressed and with smaller, shallow punctures, punctures becoming larger and striæ impressed on apical half; interstriæ flat on basal half, becoming convex, finely and sparsely uniseriate punctate; on declivity the interstriæ are narrower and more convex, and bear fine, yellow hairs.

Specimen in the British Museum.

MALAYA: Selangor, Kepong, January 18, 1949, in wood of *Dryobalanops oblongifolia* (Dipterocarpaceæ), cut tree, in association with the female, *F.G.B. 4615*.

CRYTOXYLEBORUS CONFUSUS Browne, n. nov.

2.3 mm long, nearly 3.0 times as long as wide; subcylindrical, brown, mainly subnitid but by no means shining. Head deeply concealed below pronotum, front planoconvex, subnitid, strongly and densely punctured, reticulate above. Eyes smaller than in female. Pronotum 1.36 times as long as wide, base very slightly sinuate, basal angles subrectangular, sides straight and parallel to apical third, apex rounded and armed with a row of low asperities, median pair a little more prominent, surface very weakly and almost evenly convex from base to apex, anterior half densely covered with fine granular asperities, these extending further back on disc than at sides, basal half densely, moderately finely punctured, punctures separated by spaces about as wide as their diameter; vestiture of sparse, fine, erect hairs on anterior slope and a fringe of short, recumbent hairs along basal margin. Scutellum small and depressed. Elytra as wide as pronotum and 1.1 times as long, bases transverse, sides subparallel to apical third, apex angulately rounded, disc cylindrical, declivity beginning at about apical third, very weakly depressed; disc subnitid, subglabrous, densely and finely punctured without serial arrangement; declivity subopaque, very densely, finely punctured and bearing fine, short hairs.

A specimen in the British Museum.

SARAWAK: Semengoh, August 7, 1959, *ex* branch of fallen *Shorea* sp. (Dipterocarpaceæ), in association with the female, *F.G.B. 6371*.

Genus PROWEBBIA novum

To the highly evolved genus *Webbia* Hopk., and the even younger *Xelyborus* Sch., there must now be added a third and

slightly more primitive genus, which has all the essential characters of *Webbia* except that the funicle of the antenna is five-segmented, and the pronotum just a little less cylindrical. *Pseudowebbia* m. (in press) differs in having the antennal club not obliquely truncate, the asperities of the anterior part of the pronotum not granular, and extending further back at the sides than on the disc.

Subfamily Ipinæ, tribe Webbini. Adult female cylindrical, sparsely clothed with fine, simple hairs. Head without trace of a rostrum. Eyes rather large, emarginate. Antenna inserted near emargination of eye; scape clavate; funicle five-segmented, 2nd to 5th segments subequal in length and successively wider; club circular, obliquely truncate. Mandible strong, toothed at apex. Maxillary male fringed with fine setæ. Maxillary palp three-segmented, basal segment as long as wide, 2nd very short, 3rd much longer than wide. Labium with mentum widened from base to apex. Labial palp with basal segment large, cylindrical, longer than wide, its outer side densely pubescent, apical segments very small. Pronotum longer than wide, cylindrical (but slightly less so than in *Webbia*), antero-lateral angles distinct and broadly rounded, apex subtransverse and unarmed, anterior slope obliquely convex and finely granulate-asperate, granules extending further back on disc than on sides, summit situated well in front of middle, basal area punctured, base not margined but fringed with recumbent hairs. Scutellum concealed. Elytra with bases almost straight, oblique, so that humeral angles lie distinctly further forward than scutellar angles (as in *Webbia*), and fringed with hairs, apex abruptly truncate, declivital face subcircular and acutely margined all around. Anterior coxæ subcontiguous, other coxæ rather narrowly separated. All tibiæ with inner edge more or less straight and ending in a fine spur, outer edge almost evenly curved, so that tibia is widest at middle, and the greater part of its length bearing fine, subequal, evenly spaced, short, socketed spines. Tarsi simple. Metepisternum visible along its entire length. Abdominal sternites horizontal.

Type of genus: *P. subuculæ* sp. nov.

PROWEBBIA SUBUCULÆ sp. nov.

Female.—Cylindrical, subnitid with elytral declivity matt, pronotum yellowish brown, elytra darker, particularly at the apex, the appendages and greater part of the ventral surface yellowish; 2.3 mm long, 3.0 times as long as wide. Front convex,

subnitid, rather closely punctured, becoming smooth and shining towards vertex. Eyes large, extending slightly on to front, emarginate. Pronotum nearly 1.3 times as long as wide, base transverse, basal angles rectangular, sides parallel to apical third, anterolateral angles broadly rounded, apex subtransverse, surface obliquely convex in front, summit situated at about anterior third and not prominent, posterior area cylindrical; anterior slope densely and finely granulate-asperate on a minutely reticulate ground, asperities not larger in anterolateral angles, not extending behind apical fourth at sides, becoming smaller and more granular at summit, posterior area reticulate, finely but densely punctured, punctures separated by spaces a little wider than their diameter; vestiture of sparse, fine, erect hairs on anterior slope, shorter fine hairs elsewhere and a fringe of fine recumbent hairs along basal margin. Scutellum concealed by closed elytra. Elytra as wide as pronotum and nearly 1.4 times as long, bases straight and oblique, so that humeral angles lie further forward than scutellar angles, sides parallel, apices separately rounded, disc cylindrical, declivity beginning at apical seventh, abruptly truncate, its face circular and acutely margined all around, margin unarmed; disc subnitid, finely and rather indistinctly seriate punctate, striæ not impressed, their punctures separated by spaces about as wide as their diameter, interstriæ flat, smooth, minutely and sparsely punctured; face of declivity matt, reticulate, finely, evenly and very densely granulate; vestiture of a few moderately long hairs near base at sides and on basal margin, fine, short hairs arising from interstrial punctures, and similar short hairs on margin of declivity.

Holotype and paratype in the British Museum; another paratype in my collection.

SARAWAK: Bungo Hills, at about 4,000 ft., October 10, 1957, settling on a white shirt, about sunset, E.F. Brunig coll., *F.G.B. 5879*.

WEBBIA PISCECAUDA sp. nov.

The fifth known species of the *pabo* group. It is closely related to *W. platypoides* Egg., but quite easily distinguished, as shown in the following key to the adult females of the group:

1. Apical processes of elytra not strongly widened from base to apex, their upper and longer edges subparallel ..... *pabo* Samps.
   Apical processes of elytra strongly widened from base to apex 2

2. Posterior edge of each apical process weakly convex and surmounted by a small hook; processes divergent, not concealing, produced apical satural angles of elytra when viewed from above. ..... *biformis* Brne.
Posterior edge of each apical process concave ..... 3.
3. Posterior edge of each apical process weakly and more or less evenly concave, processes not divergent, thus almost entirely apical sutural angles of elytra from above ..... *piscecauda* sp. nov.
Posterior edge of each apical process somewhat angulate, thus dividing process into two lobes; processes slightly divergent, not concealing apical sutural angles of elytra from above ..... 4.
4. Lobes of apical processes relatively narrow and acute, upper lobe distinctly longer than lower lobe ..... *platypoides* Egg.
Lobes of apical processes relatively broad and obtuse, upper lobe not much longer than lower ..... *obtusispinosus* Sch.

Female.—2.8 to 3.0 mm long (including apical processes), 3.8 times as long as wide, cylindrical, subnitid, disc of elytra pale testaceous, appendages yellowish, remainder black or almost so. Front convex, subnitid, reticulate and moderately strongly punctured, with a fine, long, raised median line. Pronotum 1.5 times as long as wide, base transverse, basal angles subrectangular, sides straight and parallel from base to broadly rounded antero-lateral angles, apex transverse when viewed from above, surface cylindrical, very feebly convex in anterior third and vertical at extreme apex; anterior slope finely and densely granulate-asperate on a finely reticulate ground, asperities extending farther back on disc than at sides, larger in antero-lateral angles, basal two-thirds reticulate, moderately finely and evenly punctured; vestiture of sparse, erect hairs on anterior slope, and a fringe of recumbent hairs on basal margin. Scutellum visible, small, triangular. Elytra as wide as pronotum and 1.55 times as long (including processes), bases straight, oblique and fringed with recumbent hairs, sides straight and parallel, apico-lateral angles weakly produced, apical sutural angles drawn out to form a pair of fine spines, disc cylindrical, declivity abruptly but rather obliquely truncate, subcircular, its margin acute, pubescent, and rather irregularly armed with fine, very short spines, upper sutural spines a shade longer than the others; disc with a short basal area dark and rugose, then pale testaceous and finely punctured, a serial arrangement evident but not easily distinguished; declivity subnitid, rugose, the striæ evident and with punctures stronger than on disc, interstriæ with rather strong, uniseriate, piliferous granules; at about middle of declivity, on each side, arises a conspicuous, chitinous process bearing some fine, rather long hairs, process

strongly widened from base to apex and produced into a long, acute upper point and a shorter, blunter lower point, apical edge weakly and almost evenly concave, two processes not widely divergent, thus almost entirely concealing apical sutural angles of elytra when viewed from above.

Holotype in the British Museum; paratypes in the British Museum and in my collection.

MALAYA: Kelantan, Pulai Chondong, November 12, 1946, in wood of *Quercus* sp. (Fagaceæ), dying tree, types, *F.G.B. 3743*; same locality, in wood of *Quercus* sp., cut tree, *F.G.B. 3690*.

The suggested host-association with the Fagaceæ is unusual. With the exception of *W. costulatulus* Sch., which is associated with Sapotaceæ, all other known species of the genus normally select their hosts in the family Dipterocarpaceæ.

NEW SPECIES AND SYNONYMY OF PLATYPODIDÆ

PLATYPUS FRANCIÆ sp. nov.

A small species of the Platypi Oxyuri, distinguished by having a group of fine pores on the pronotum.

Male.—2.5 mm long, 3.85 times as long as wide, head and pronotum black or almost so, elytra and appendages brown. Front flat, matt, reticulate, moderately strongly and evenly punctured, a narrow strip above mouth smooth, subnitid and more sparsely punctured, a median striga scarsely evident; vertex rounded into front, smooth, subnitid, with large, shallow, irregularly shaped punctures and rather short, erect hairs, median line weakly raised. Pronotum 1.2 times as long as wide, widest at posterior angles of femoral grooves, grooves situated at about middle, deep and angled at both ends, median sulcus fine, extending to basal third, at its apex a rather small, V-shaped group of fine pores, remaining surface subnitid, finely wrinkled, particularly near base and apex, moderately finely and rather densely punctured, along apex some deeper, piliferous punctures. Elytra scarcely wider than pronotum and 2.0 times as long, base scarcely raised, side subparallel to about apical third, apices not quite jointly acuminate, separated by a narrow V-shaped space, each apex truncate, its sutural and lateral angles marked by a small acute tooth, and its lower edge produced downwards to form a rather long, acute tooth; surface cylindrical in basal half, then gradually and very obliquely declivous, small apical face vertical; disc and declivital convexity finely seriate punctate, striæ weakly impressed, their punctures closely spaced, inter-

striæ flat, all reaching base, near base smooth but becoming distinctly rugolose from about basal third, moderately finely and irregularly punctured, and each with a row of bright hairs on declivital convexity, interstrial punctures scarcely smaller than those of striæ; apical vertical face densely pubescent.

Holotype and paratypes in the Forest Products Research Institute, Laguna; other paratypes in the British Museum and in my collection.

PHILIPPINES: Laguna, Mt. Maquiling, October 31, 1958, V.P. Asis coll.

TRACHYOSTUS LONGICOLLIS Browne, comb. nov.

Crossotarsus longicollis BROWNE, Ann. Mag. Nat. Hist. 12 (1950) 649–650.

Any rational classification of the Platypodidæ demands recognition of Schedl's genus *Trachyostus*, although I cannot agree that it is more closely related to *Platypus* than to *Crossotarsus*. A number of species of the former Crossotarsi Subdepressi await transfer, including *C. longicollis* m.

In the original description of *C. longicollis* (male), I omitted to mention that the first visible abdominal sternite bears a long, acute, backwardly directed spine.

TRACHYOSTUS PARVUS sp. nov.

A small species of the Trachyosti Forficuli. It is related to *T. longicollis* m, but the latter is considerably smaller still, its pronotum is distinctly more elongate, and the apical angles of the elytra less strongly produced, the space between them therefore shallower.

Male.—Subnitid, brown, apex of elytra darker; 3.0 mm long, 3.8 times as long as wide. Front subnitid, flat, densely, evenly and strongly punctured, median striga distinct and long; vertex rounded into front, with large but shallow and inconspicuous punctures, median line fine and not raised. Pronotum 1.1 times as long as wide, femoral grooves not very deep, angled anteriorly, median sulcus extending to basal third, surface evenly and densely covered with large but very shallow punctures. Elytra scarcely wider than pronotum and twice as long, basal margin scarcely raised, sides subparallel to apical fourth, then slightly incurved, apical angles strongly produced downwards and acute, space between them subsemicircular, disc cylindrical, declivity beginning at about apical third, obliquely convex, vertical apical rim narrowly lunate; disc smooth, very

finely and indistinctly seriate-punctate, striæ not impressed, their punctures rather irregularly spaced, interstriæ broad, flat and subimpunctate, all except 4th reaching basal margin; on declivital convexity the striæ are impressed, without distinct punctures, the interstriæ evenly and not very strongly carinate, finely uniseriate granulate and bearing rather coarse, yellow hairs; apical impression smooth, shining. First visible abdominal sternite with an acute, backwardly directed spine; apical sternite large, not very densely covered with moderately large, shallow, circular punctures.

Holotype and one paratype in the Forest Products Research Institute, Laguna; 2 paratypes in my collection.

PHILIPPINES: Laguna, Mt. Maquiling, December 7, 1958, *ex* Dipterocarpaceæ, F. C. Francia Coll.

CROSSOTARSUS CINCINNATUS Chapuis.

(*C. penicillatus* Chap. syn. nov.)
Crossotarsus cincinnatus CHAPUIS, mas (lege fem.), Monogr. des Platyp. (1865) 57.
Crossotarsus penicillatus CHAPUIS, fem. (lege mas.), l.c., p. 64.

Both Sampson [Ann. Mag. Nat. Hist. (9) 4 (1919) 105] and Beeson [Ind. For. Rec. (N. S.), (3) 3 (1939) 54] have voiced the suspicion that *C. cincinnatus* and *C. penicillatus* are sexes of the same species, but neither author insisted on the synonymy. There is, however, no reason to doubt it. The type of *C. cincinnatus* is in the British Museum, and exactly similar specimens have on frequent occasions been taken in association with males that precisely fit Chapuis' lucid description and figure of *penicillatus*. A specimen in the British Museum, labelled by Schedl as "*Crossotarsus cincinnatus* Chap., male type," and described by him in Journ. F.M.S. Mus. 17 (1935) 639, is a male of *C. schedli* sp. nov.

As far as present knowledge goes, *C. cincinnatus* is confined to Borneo and, although several specimens are rather vaguely labelled, it seems to have been found only in southern Sarawak, where, however, it is not uncommon.

The following specimens are in the British Museum: Sarawak, A. R. Wallace coll., type; Sarawak, Kuching, February 12, 1914; no locality cited, 1911, Janson coll., a good series of both sexes; Sarawak, Kuching, Matang Road, January 2, 1910; Sarawak, Matang, December, 1917, G. E. Bryant coll.; Sarawak, without further details; Sarawak, Matang, December, 1913, G. E. Bryant

coll., a good series of both sexes; Sarawak, Kuching, March 16, 1914, several of both sexes; Sarawak, Matang, April 8, 1911; Borneo, without further details; Sarawak, Kuching.

I have the following more recent records: Sarawak, near Kuching, June 21, 1957, one male in branch of fallen tree, *F.G.B. 5795;* Sarawak, Simanggang, several of both sexes in log of *Copaifera palustris* (Leguminosæ), L. P. Zehnder coll., *F.G.B. 5881;* Sarawak, Triso, November 25, 1957, several of both sexes in unidentified log, L.P. Zehnder coll., *F.G.B. 5911.*

CROSSOTARSUS SCHEDLI sp. nov.

Crossotarsus cincinnatus Schedl, nec CHAPUIS, Journ. F.M.S. Mus. 17 (1935) 639.

As a result of a misidentification of the female, Schedl described a Malayan specimen as the male of *C. cincinnatus* Chap. This, as Beeson, [Ind. For. Rec. (N. S.) (3) 3 (1939) 54] has suggested, requires a new name. The true *C. cincinnatus* Chap. is not known to occur in Malaya, and all Malayan specimens previously identified as such should be referred to this new species. It is also probable that Schedl's records of *C. cincinnatus* [Philip. Jour. Sci. 80 (1951) 365] from Sumatra, Borneo and the Philippines refer to *C. schedli.* In Malaya, it is one of the more common representatives of the Crossotarsi Genuini.

Male.—The male has been described by Schedl (l.c.). It is distinguished from the male of *C. cincinnatus* Chap. by differences in sculpture of the front and elytra, in having distinctly shorter and less well defined teeth at the elytral apex, and in lacking a low tubercle on the apical abdominal sternite.

Female.—6.5 mm long, 3.2 times as long as wide, cylindrical, subnitid, black, disc of elytra brown, appendages and the greater part of ventral surface yellow. Front deeply hollowed, upper concavity with a large median pit and sharply separated from a lower, flattened area, not continued downwards as a sulcus, lower area shallowly punctured with a distinct, impressed median line, finely granulate above mouth; interocular carina with median emargination shallow but well defined, lateral angles rounded and not salient over eyes; lateral carina rounded, strongly developed in front of eye. Antennal scape with upper prolongation blunt, more than one-third of the whole length of scape, lower prolongation of similar shape but a little shorter. In young, uncorroded specimens the head is

densely pubescent, hairs arranged as follows: on each side of interocular carina, a dense fringe of very long, yellow hairs, curled forwards and downwards, and almost concealing median emargination; lateral carina with a fringe of fine hairs; upper concavity of front with dense, fine hairs towards lower margin; antennal scape, except upper prolongation, with dense hairs, similar to those of interocular carina but a little shorter. Pronotum quadrate, as in male, median sulcus distinct to basal fourth but continued almost to apex as a feebly impressed line, surface minutely areolate, finely and sparsely punctured, basal third of disc subimpunctate. Elytra a little wider than pronotum and 1.9 times as long, sides subparallel to apical third, then slightly incurved, apico-lateral angles acute but scarcely produced, apex very broadly rounded, disc cylindrical, declivity short, obliquely convex at first, almost vertical at extreme apex; disc moderately strongly seriate-punctate, striæ weakly impressed, their punctures rather shallow, becoming smaller and shallower towards apex, separated by spaces almost as wide as their diameter, interstriæ flat, finely punctured, punctures biseriate near base but becoming irregularly uniseriate, bases of 1st, 3rd and 5th interstriæ raised and joined; striæ lost at apex, where interstriæ become finely granulate and bear erect, yellow hairs.

The female of *C. cincinnatus* Chap. differs principally as follows: Front not divided into distinct upper and lower parts, but separated from epistome by a large depression on each side; on upper half, on each side, is a rounded swelling, joined to side by a transverse ridge. Median emargination of interocular carina very broad, shallow and not sharply defined, so that the greater part of the anterior edge of carina appears weakly concave. Lower prolongation of antennal scape acute.

Holotype (male) and allotype (female) in the British Museum.

MALAYA: Selangor, Kepong, June 6, 1950, *ex* fallen *Castanopsis sumatrana* (Fagaceæ), *F.G.B. 5341*.

DIACAVUS DIAPHANUS Sch., n. nov.

Male.—Cylindrical, mainly subnitid, pronotum and most of the head black, front brownish, base and apex of elytra dark brown to black, the greater part of disc testaceous and translucent, appendages yellowish, prosternum yellowish, remainder of underside dark brown to black; 2.5 mm long, 3.8 times as long as wide. Front flat, shining, with rather sparse, fine

punctures and fine, erect hairs; vertex rounded into front, matt, reticulate, finely punctured on each side of a distinct shining median line, towards sides smooth and shining. Antenna inserted on front at level of lower margin of eye, scape with rather long, slightly curled hairs. Pronotum 1.25 times as long as wide, of normal *Diacavus* form, sides not abruptly divergent anteriorly, median sulcus short and fine, surface almost smooth, shining, irregularly and rather finely punctured, subglabrous, with a few fine, erect hairs near apex and finer, shorter hairs along basal margin, no large pores. Elytra as wide as pronotum and 1.7 times as long, sides straight and very slightly divergent, apex truncate and toothed, with a very narrow, vertical apical rim; surface horizontal from base to apex, smooth, with rather irregular rows of shallow, not very distinct, widely spaced punctures, becoming sulcate in the dark area near apex, interstriæ impunctate; each elytron ending in 5 flat, bifid teeth of equal length and breadth, points of outermost distinctly unequal, inner point being much longer than outer, each tooth with a few fine, long hairs. Fourth visible abdominal sternite forming a projecting hyaline structure, consisting of alternately longer and shorter brown bristles connected by a transversely striated membrane, points of longer bristles projecting slightly beyond membrane.

Specimen in the British Museum.

SARAWAK: Semengoh, January 25, 1957, in association with the female.

DIACAVUS HATICOLLIS sp. nov.

A species characterized by having the pronotum considerably wider than is usual in the genus; and very irregularly sculptured elytra.

Male.—Mainly subnitid, black, disc of elytra and appendages brown, underside paler; 3.2 mm long, 3 times as long as wide. Front subnitid, its surface flat but rather uneven, finely shagreened, punctures rather sparse, fine and shallow. Antennæ inserted on front, far within margin of eyes. Vertex separated from front by an obtusely rounded angle, subnitid, minutely reticulate, finely, sparsely and shallowly punctured, median line conspicuous and shining. Pronotum as wide as long, widest at about basal fourth, of normal general *Diacavus* form, subnitid minutely shagreened and very finely, sparsely, shallowly punctured, punctures along anterior margin stronger

and piliferous; no evident median sulcus or pores. Elytra wider than pronotum and 1.8 times as long, sides straight and subparallel, apex truncate and toothed, surface horizontal from base to apex, distinctly shagreened, subnitid, seriate punctate, striæ rather strongly impressed towards base but flattening out in apical half to third, their punctures moderately fine near base, becoming very coarse and closely spaced but rather shallow at about middle, again becoming smaller and ending before the apex, the interstriæ weakly but distinctly raised towards base, then flattening out as the striæ become shallower, their puncture varying in size as those of the striæ but smaller, much sparser, and rather irregularly spaced, interstriæ produced at apex to form blunt, subtruncate teeth, those of the 1st to 4th interstriæ broad and subequal, outer teeth successively smaller and decreasing to small serrations; surface glabrous except for a few long hairs at apex.

Holotype in the British Museum; a paratype in the Forest Research Institute, Malaya.

MALAYA: Selangor, Keping, August 2, 1955, in log of *Shorea leprosula* (Dipterocarpaceæ), K. D. Menon coll., (*F.R.I. 0349* and *0358*).

DIACAVUS QUADRIDENS sp. nov.

A species of moderate size with very distinctly punctulate elytra, the male easily recognized by its apical armature.

Male.—Subnitid, black, appendages and most of the underside yellowish; 2.8 mm long, 3.4 times as long as wide. Front flat, subnitid, sparsely and finely punctured, more strongly so towards vertex, median line long and distinctly raised; vertex separated from front by a rounded angle, smooth, sparsely and rather finely punctured, median line not evident. Antennæ inserted near lower inner margin of eyes. Pronotum 1.2 times as long as wide, of usual *Diacavus* form, median sulcus fine and short, with a pair (sometimes only one) of large, circular pores at its base, surface minutely punctulate except at the middle of disc, finely and very sparsely punctured, along the base an irregular series of minute hairs. Elytra a shade wider than pronotum and 1.7 times as long, sides straight and very slightly divergent, apex truncate and toothed, surface horizontal from base to apex, densely and distinctly punctulate, rather irregularly and moderately finely seriate punctate, 1st to 4th striæ becoming impressed just before apex, strial punctures widely

and irregularly spaced, 1st interstria narrow throughout, 2nd and 4th produced to form broad, irregularly spaced teeth, 3rd narrowed and not produced, outer interstriæ jointly forming an irregular acute edge which projects as far as teeth, the whole apical margin with sparse, long hairs. Apical abdominal sternite large, subcircular, moderately strongly punctured.

Female.—3.0 mm long, 3.6 times as long as wide, color as in male. Front flat, subnitid, sparsely and finely punctured, with a distinct, impressed median line; on each side, near inner margin of eye, arises a large brush of yellow hairs that projects far forwards and then curls downwards; from each side of the epistomal margin arises a finer, shorter, upcurled brush of yellow hairs; vertex separated from front by a rounded angle, punctulate and with scattered punctures, median line weakly raised. Antennæ inserted on front, at level of upper inner margin of eyes. Pronotum as in male but with 3 (sometimes 2) pores on each side of base of median sulcus. Elytra a little wider than pronotum and 1.7 times as long, sides subparallel, apices separately very broadly rounded, disc cylindrical, declivity very short and obliquely convex; sculpture of disc as in male, declivity very finely pubescent. Apex of abdomen visible from above, finely punctured and pubescent.

Holotype (male), allotype (female), and paratypes in the Forest Products Research Institute, Laguna; other paratypes in the British Museum and in my collection.

PHILIPPINES: Mt. Maquiling, Laguna, December 7, 1958, M. L. Garcia coll., *ex* Dipterocarpaceæ (holotype); same locality, November 23, 1958, F. C. Francia coll., *ex* Dipterocarpaceæ, (allotype).

MALAYA: Selangor, Kepong March 4, 1948, in log of *Shorea leprosula* (Dipterocarpaceæ); same locality, August 8, 1950, in log of *Drybalanops oblongifolia* (Dipterocarpaceæ).

DIACAVUS EXILIS Sch., fem. nov.

Female.—2.0 mm long, 4.5 times as long as wide, very dark brown to black, underside and appendages yellow. Front flat, finely and densely punctured except for a fine median line; in young specimens the upper part of front bearing two long brushes of stiff, brownish hairs, lying close together projecting far forwards and curled downwards at their tips. Antenna inserted on front near upper inner angle of eye. Vertex shagreened, and with a weakly raised median line. Pronotum

1.4 times as long as wide, of usual *Diacavus* form, sides not very strongly divergent anteriorly; median sulcus extending to about basal third, on each side of its base 1 or 2 large, circular pores, and on each side of these a more or less semicircular area containing numerous smaller pores and some minute hairs; remainder of surface shagreened and with very sparse, fine punctures. Elytra scarcely wider than pronotum and 1.8 times as long, sides straight and subparallel, apices separately, very broadly rounded, surface cylindrical, shagreened, with scattered, fine, shallow punctures but scarcely evident serial arrangement, towards apex with rather sparse, fine, short hairs.

Specimens in the British Museum and in my collection.

SARAWAK: Serapah, April 17, 1959, in log of *Vatica* sp. (Dipterocarpaceæ), in association with the male.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XLVII *

By Charles P. Alexander
Amherst, Massachusetts

FIVE PLATES

In the present report I am discussing a part of the Tipulidæ taken by Dr. J. Linsley Gressitt in 1955 in two widely separated sections of New Guinea. This was the first trip to the great island by the Director of the Pacific Insect Survey whose detailed report on the subject has been published elsewhere.[1] A summary of the more important localities where Tipulidæ were taken is provided:

1. *Northeast New Guinea highlands.*—Daulo Pass, northwest of Goroka, 2,450 meters, June 11 to 16; Denglagu, near Mount Wilhelm, 2,350 to 2,400 meters, June 29 to July 3; Goroka, Asaro Valley, southeast of Mount Wilhelm, 1,550 meters, June 21 to 25. Kabebe, foot of Mount Otto, 2,100 meters, June 21 to 24; Korop, 1,300 meters; Miramar, 1,800 meters, June 27. Nenguag, 2,200 meters, June 28. Nonjugl, Ahl Valley, July 6 to 9. Mount Otto, east side of Asaro Valley, 2,100 to 2,600 meters, June 22 to 24; Mount Wilhelm, 2,700 meters, July 4 to 5.
2. *Wisselmeren area, west-central Netherlands New Guinea.*— Enagotadi (Enarotadi), 1,750 to 2,050 meters, July 31 to August 7; Itouda, 1,500 to 1,750 meters, August 12 to 14. Okaitadi, west end of Paniai Lake, 1,760 to 1,800 meters, August 7 to 8; Wissel Lakes (Wisselmeren), Paniai Lake (largest), 1,742 meters, Tage Lake (smallest), 1,765 meters.
3. *Lae area, Northeast New Guinea.*—Along Busu River and in the Nadzab Valley at Bubia, September 14 to 20.

The types of the novelties and representatives of the species considered at this time will be deposited in the Bishop Museum, Honolulu. My deepest thanks are extended to Dr. Gressitt for the privilege of studying this important series of crane-flies.

HISTORICAL DEVELOPMENT OF OUR KNOWLEDGE OF THE CRANE-FLIES OF NEW GUINEA

Over the years various collection of Tipulidæ have been taken in New Guinea and it is believed that a brief summary of the more important of these may be of interest.

* Contribution from the Entomological Laboratory, University of Massachusetts.

[1] Gressitt, J. L. Entomological investigations in New Guinea Mountains. Proc. Hawaiian Ent. Soc. 16 (1956) 47–69, 10 figs., including map.

The earliest materials were from Manokwari (Dorey, Dorei, of Wallace) in the Vogelkop of extreme northwestern Netherlands New Guinea, to the west of Geelvink Bay. These were taken by Alfred Russel Wallace in 1858 and were described in various papers by Francis Walker.

In the early years of the present century various Dutch and British expeditions, chiefly to Netherlands New Guinea, secured a few species of these flies that were discussed by Edwards and de Meijere. Somewhat earlier (1895 to 1902) the entomological collector Ludwig Biró had made important collections in the Morobe District of Northeast New Guinea, chiefly in the vicinity of Salamaua and Huon Gulf (then Kaiser Wilhelm Land in German New Guinea). Biró's materials were discussed by Riedel and by the present writer.

In 1933 and 1934 the veteran collector of Pacific insects, Miss Lucy Cheesman secured large and valuable lots of specimens in Papua, chiefly at Kokoda, Mafulu and on Mount Tafa, in the Owen Stanley Range. This was followed in succession by her later expeditions to the Cyclops Mountains, near Hollandia, in 1936; to the islands of Waigeu and Japen, off the northwestern coast, in 1938; and to the Torricelli Range in Northeast New Guinea in 1939. These important materials are preserved in the British Museum and have been discussed in various reports by the writer. In 1935 the late Frank H. Taylor collected in the Morobe District of Northeast New Guinea, chiefly along Edie Creek near Wau, in the watersheds of the Watut and Markham Rivers flowing into Huon Gulf. The large series of species taken by Taylor have been discussed in earlier reports by the writer. Also in 1935 a further small series of these flies was taken in Papua by Mr. K. J. Clinton.

During the recent wartime operations in New Guinea, various American entomologists collected crane-flies in New Guinea, particularly in the vicinity of Hollandia and the Cyclops Mountains, the most important materials having been taken in 1945 by Drs. Harry Hoogstraal and Jean Laffoon. At about the same time additional lots of these flies were taken in the various eastern satellite islands, particularly Bougainville and Guadalcanal in the Solomons, between 1943 and 1945, by Drs. Clifford O. Berg, Ashley B. Gurney, Richard T. Holway, Robert Staples, and some others.

At the present time some further very important collections of these flies are being studied by the writer and are being

discussed in other papers. The largest and most important of these results from the Third Archbold Expedition of 1938 and 1939, from Hollandia on the north coast to high altitudes in the Snow Mountains of east central Netherlands New Guinea. The entomologist of the expedition, the late Dr. Lambertus Johannes Toxopeus, secured an incredible amount of insects in many groups, including the Tipulidæ. These are being described in a separate series of reports, the first of which [2] lists the various collecting stations established by the party.

The Fourth Archbold Expedition to northeastern Papua in 1953 likewise brought back large and varied collections of these flies, despite the fact that they were taken somewhat incidentally to other activities, by the botanist, Dr. L. J. Brass, and the mammalogist, Mr. Geoffrey M. Tate. This expedition stressed particularly Mount Dayman in the Maneau Range and Goodenough Island in the D'Entrecasteaux Group off the eastern coast of Papua. This series of flies is being studied by the writer at the present time.

Still further important collections of Tipulidæ have been made in New Guinea in conjunction with the Pacific Insect Survey of the Bishop Museum, as outlined in the series of papers and unpublished reports by the Director, Dr. Gressitt. Entomologists who collaborated in these most recent surveys include, besides the Director, Messrs. William W. Brandt and E. J. Ford, Jr., in 1956, Dr. D. Elmo Hardy in 1957, and Drs. Tsing-chao Maa and Larry Quate in more recent years. All such surveys of the past and those in operation at the present time will culminate in the comprehensive review of the Tipuloidea of New Guinea now in preparation by the writer.

CYLINDROTOMINÆ

STIBADOCERA LUTEIPENNIS sp. nov. **Plate 1, fig. 1.**

Size relatively large (wing of male 10.5 millimeters; antenna 18); mesonotal præscutum and scutal lobes polished dark brown, pleura chiefly brown, the mesepisternum darker; halteres with stem yellow, knob light brown; wings broad, uniformly pale yellow, veins light brown; R_{2+3} suberect to oblique, gently sinuous; basal section of M_3 strongly arcuated, nearly twice m; cell 2nd A relatively wide, especially on outer half; abdomen

[2] Alexander, C. P. New or little-known Tipulidæ (Diptera). CVI. Oriental-Australasian species. Ann. Mag. Nat. Hist. (13) 1 (1958) 657–676, 9 figs.

brownish yellow, posterior borders of tergites broadly dark brown, producing an annulated appearance; hypopygium dark brown.

Male.—Length, about 11 millimeters; wing, 10.5; antenna, about 18.

Rostrum very reduced, yellow; palpi pale brown, remainder of mouth-parts darker. Antennæ of male very long, as shown by the measurements; scape and pedicel yellow, tinged with green, flagellum yellow; flagellar segments very long-cylindrical, with abundant long erect setæ, the longest subequal to or longer than the segments. Front and anterior vertex yellow; posterior vertex polished brownish yellow, weakly infuscated on orbits behind the antennal fossæ.

Prothorax light yellow. Mesonotal præscutum and scutal lobes polished dark brown, without punctures; scutellum testaceous yellow; postnotum brown. Pleura chiefly brown, the mesepisterum darker brown, including the sternopleurite; propleura pale. Halteres elongate, stem yellow, knob light brown. Legs with coxæ and trochanters pale yellow; remainder of legs broken. Wings (Plate 1, fig. 1) broad, uniformly yellow; veins light brown, paler in the basal and costal fields. Macrotrichia of veins of outer half of wing small but abundant. Venation: Second section of Rs about one-half longer than r–m; R_{2+3} suberect to oblique, gently sinuous; cell 1st M_2 large, basal section of M_3 strongly arcuated, nearly twice m; m–cu at near two-thirds M_{3+4}, shorter than the distal section of Cu_1; cell 2nd A relatively broad, especially on outer half.

Abdomen elongate, brownish yellow, the posterior borders of the tergites broadly dark brown, presenting an annulated appearance; second segment with a dusky ring beyond midlength; eighth segment light yellow, the posterior border of tergite infuscated; hypopygium dark brown; sternites more uniformly brownish yellow.

Habitat.—Northeast New Guinea.

Holotype, male, Daulo Pass, altitude 2,400 meters, at light, June 13, 1955 (*Gressitt*).

The three species at present known from New Guinea include also *Stibadocera daymanensis* Alexander and *S. papuana* Alexander, all distinguished among themselves by the coloration of the body and wings, length of the body and male antennæ, and in the details of venation. It seems probable that in living

specimens of the present fly that the green coloration above indicated will be more evident.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) PERISSOPTERA sp. nov.

Size medium (wing of female 7 millimeters); general coloration of mesonotum pale brown, præscutum with a broad darker central stripe, pleura dark brown; antennæ black throughout; legs medium brown, claws entirely untoothed; wings subhyaline, stigma small, pale brown; Sc long, cell M_2 open by atrophy of basal section of M_3, m–cu lacking; cerci very slender, the tips acute.

Female.—Length, about 6 millimeters; wing, 7.

Rostrum and palpi dark brown, the latter small. Antennæ black throughout; flagellar segments oval, a little longer than the verticils, strongly constricted at the incisures. Head in front, on anterior vertex and narrow orbits silvery gray, the posterior part of head darker; anterior vertex relatively narrow, about equal to two rows of ommatidia or slightly less than one-third the diameter of the scape.

Cervical region and pronotum brown, pretergites light brown. Mesonotal præscutum with a broad dark brown central stripe, the lateral parts paler brown; scutum dark brown, scutellum more testaceous; mediotergite reddish brown, gray pruinose. Pleura chiefly dark brown, dorsopleural region paler; sclerites above the middle and hind coxæ narrowly yellowed. Halteres infuscated, stem obscure yellow, brighter at base, with conspicuous setæ on other half. Legs with fore coxæ infuscated, remaining coxæ and trochanters yellow; remainder of legs medium brown; claws entirely untoothed. Wings (Plate 1, fig. 2) subhyaline to faintly suffused; stigma pale brown, small, subcircular; veins delicate, very pale brown. Macrotrichia of veins long and conspicuous, on all longitudinal veins beyond cord; basad of this on Rs, outer fourth of M and distal third of Cu_1, none on anal veins. Venation: Sc long, Sc_1 ending about opposite two-thirds Rs, Sc_2 near its tip; free tip of Sc_2 and R_2 in transverse alignment; cell M_2 open by atrophy of basal section of M_3, cell 2nd M_2 nearly three times its petiole; m–cu entirely lacking; vein 2nd A long, gently sinuous at near midlength.

Abdomen dark brown, subterminal segment obscure yellow. Ovipositor with cerci very slender, gently upcurved to the acute tips.

Habitat.—Northeast New Guinea.

Holotype, female, Mount Wilhelm, altitude 2,700 meters, at light, July 4, 1955 (*Gressitt*).

This surprising fly is entirely distinct from all other known crane-flies in the loss of vein m-cu of the wings. Although only the unique type is available I feel that the condition is normal and not adventitious. The wings of the two sides are quite alike as regards the venation.

LIMONIA (LIBNOTES) ALTERNIMACULA sp. nov. Plate 1, fig. 3.

Mesonotal præscutum brownish yellow, variegated with brownish black on posterior half, without lateral darkening; pleura light yellow, with a black longitudinal stripe, pteropleurite and sternopleurite entirely pale; femora yellow with a narrow brownish black subterminal ring; wings whitened, variegated with brown spots and streaks, chiefly on the veins, alternating with pale areas; R_2 at or beyond the free tip of Sc_2; m angulated and spurred; cell 2nd A relatively narrow.

Female.—Length, about 9 millimeters; wing, 11.5.

Rostrum and mouth-parts pale yellow; palpi light brown, relatively short. Antennæ with scape black; remainder broken. Head brownish gray, the posterior orbits narrowly paler gray; anterior vertex behind the antennal fossæ more silvery; eyes broadly contiguous.

Pronotum yellow, the scutellum tinged with green. Mesonotal præscutum brownish yellow, including the anterior half, the posterior half with four brownish black stripes, the intermediate pair virtually contiguous, sublateral stripes distinct; no lateral præscutal darkening; scutum pale yellow, lobes dark brown; scutellum obscure yellow, posterior border darkened beneath; postnotum, including the pleurotergite and metapleural area black. Pleura light yellow, with a conspicuous black longitudinal stripe extending from the lower pronotum and propleura across the dorsal anepisternum to the wing root, the pteropleurite and sternopleurite entirely yellow. Halteres with stem yellow, apex of knob infuscated. Legs with the fore coxæ yellow, middle and hind coxæ black; trochanters greenish yellow; femora yellow, with a relatively narrow brownish black subterminal ring, subequal to or a trifle broader than the yellow

tip; tibiæ yellow, tips narrowly black; tarsi greenish yellow, outer segments black. Wings (Plate 1, fig. 3) with the ground whitened, variegated with brown spots and streaks, including three in cell Sc; stigma subcircular, small, dark brown; other small darker areas beyond arculus, cord, outer end of cell 1st M_2 and tip of vein 2nd A; a single similar subapical area on each of veins R_3, R_{1+5}, M_{1+2}, M_3 and M_4; paler brownish gray washes in centers of cells R and M, midlength of vein R_{2+3}, and as marginal clouds, very small at ends of veins R_3 and M_{1+2}, more extensive in cells M_4, Cu and 1st A; veins yellow or greenish yellow, brownish black in the most heavily patterned areas. Venation: Sc moderately long, Sc_1 ending a short distance beyond level of r-m; Rs oblique; R_2 at or beyond the free tip of Sc_2; cell 1st M_2 long, widened outwardly, m long angulated to weakly spurred before midlength, the spur jutting basad into cell 1st M_2; m-cu at near two-fifths the length of M_{3+4}; cell 2nd A relatively narrow.

Abdomen obscure yellow, the anterior lateral angles of the tergites with a small blackened spot. Ovipositor with valves blackened; cerci strongly bifid at tips; hypovalvae produced into an acute point.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, female, Enagotadi, altitude 1,875 meters, July 31, 1955 (*Gressitt*).

Generally similar to *Limonia (Libnotes) grammoneura* sp. nov., differing in the coloration of the body and wings, and in the details of venation, especially of the outer radial field.

LIMONIA (LIBNOTES) GRAMMONEURA sp. nov. Plate 1, fig. 4.

General coloration of thorax light gray, præscutum with a broad dark brown central stripe that is constricted at near midlength; rostrum yellow; antennæ black throughout; eyes contiguous above; pleura greenish yellow with two incomplete dark brown longitudinal stripes, the ventral one on the dorsal sternopleurite; knobs of halteres dark brown; femora obscure yellow, with a narrow dark brown subterminal ring; wings whitish subhyaline, the veins with brown longitudinal seams; vein R_2 oblique; cell 1st M_2 very long and narrow, m much longer than basal section of M_3; abdominal tergites yellowish green, sternites bicolored; tips of cerci and hypovalvæ notched.

Female.—Length, about 7.5 to 9 millimeters; wing, 9.5 to 12.

Rostrum yellow; palpi black. Antennæ black throughout; flagellar segments oval, with short verticils; terminal segment

elongate, the outer half strongly narrowed. Head light gray, silvery behind the antennal fossæ; eyes broadly contiguous above, ommatidia large.

Pronotal scutum light brown, paling to green on sides, scutellum greenish. Mesonotal præscutum with the ground light gray, with a broad dark brown central stripe, expanded over the cephalic end, constricted at near midlength, behind more or less confluent with the very reduced sublateral stripes, the central darkening with a vague pale median vitta; lateral præscutal border darkened; scutal lobes solidly dark brown, central area pale gray; scutellum pale medially and at base, with a large dark brown spot on either side, parascutella pale green; mediotergite dark brown, the disk slightly paler; pleurotergite dark brown, bordered anteriorly by yellow. Pleura greenish yellow, with two incomplete dark brown stripes, the dorsal one including the propleura, passing beneath the wing root, ventral stripe occupying the dorsal sternopleurite; pretergites pale green in front, dark brown before the wing root. Halteres with stem greenish, knob dark brown. Legs with coxæ strongly tinged with green; trochanters brownish yellow; femora obscure yellow, with a narrow dark brown subterminal ring; a more or less distinct darkening just beyond midlength of femur; tibiæ yellow, tips blackened; tarsi obscure yellow, outer segments blackened. Wings (Plate 1, fig. 4) whitish subhyaline, conspicuously patterned with dark brown, appearing essentially as long seams on most veins; prearcular and costal fields slightly tinted with yellow; dark pattern varying slightly in different specimens, in cases the markings more broken, in others confluent to form long streaks; veins pale yellow, very inconspicuous in the ground, much darker in the patterned areas. Venation: Sc relatively short, Sc_1 ending shortly before level of anterior end of m; R_2 oblique, usually shorter than the arcuated R_{1+2} beyond it; r–m shortened by the approximation of veins; cell 1st M_2 very long and narrow, m long, m–cu at from about two-fifths to midlength of M_{3+4}; anal veins convergent, vein 2nd A strongly arched.

Abdominal tergites light yellowish green, darkened laterally; sternites bicolored, the bases of the segments brown, apices greenish yellow; in cases the dark pattern of the whole abdomen virtually lacking. Ovipositor with the valves short, heavily sclerotized; tips of cerci somewhat unequally bifid; tips of hypovalvæ unequally notched, the lower point produced.

Habitat.—Northeast New Guinea.

Holotype, female, above Kabebe, Mount Otto, altitude 2,100 meters, June 24, 1955 (*Gressitt*). Paratopotypes, 2 females, 2,100 to 2,600 meters, June 22 to 23, 1955; paratype, female. Daulo Pass, altitude 2,400 meters, June 13, 1955 (*Gressitt*).

Generally as in *Limonia* (*Libnotes*) *alternimacula* sp. nov., differing in the coloration of the body and wings and in the details of venation, especially of the outer radial field.

LIMONIA (LIBNOTES) PHILEMON sp. nov. Plate 1, fig. 5.

General coloration of mesonotum obscure yellow, præscutum with a central reddish brown stripe that widens behind; pleura yellow, mesepisternum extensively reddish brown; femora yellow, with a relatively narrow subterminal brown ring, the subbasal parts more or less darkened, tarsi entirely yellow; wings pale yellow, with a restricted brown pattern appearing as seams to the veins; stigma yellow, completely encircled by brown; cell 1st M_2 small, pentagonal; abdomen pale green; cerci slender, simple, tips acute.

Female.—Length, about 12 millimeters; wing, 11.

Head broken. Pronotum dark brown. Mesonotal præscutum obscure yellow, with a central reddish brown stripe, very narrow and more or less broken on anterior half, expanded near the suture; lateral stripes lacking; scutum yellow, centers of lobes reddish brown; scutellum reddish brown, more yellowed at base; mediotergite dull yellow, brown on cephalic part, narrowed to a capillary central line behind; pleurotergite yellow, reddened ventrally. Pleura yellow, the mesepisternum extensively reddish brown. Halteres uniformly pale greenish yellow. Legs with all coxæ and trochanters pale yellow; femora yellow, with a relatively narrow subterminal brown ring that is only about one-half as extensive as the pale tip; basal half of femora weakly darkened beyond base, most evidently so on fore legs, lacking on middle pair; remainder of legs yellow, including the terminal tarsal segment. Wings (Plate 1, fig. 5) pale yellow, the prearcular and costal fields more saturated yellow; a restricted but conspicuous brown pattern, including seams at arculus, origin of Rs, cord and outer end of cell 1st M_2, with further marginal seams on all outer veins, very extensive on 2nd A; a small isolated brown spot at fork of M and another at midlength of vein M; stigma extensively yellow, completely encircled by brown; veins yellow, light brown in the patterned

areas. Venation: Sc long, Sc_1 ending about opposite r–m; Rs sinuous on basal half; free tip of Sc_2 and R_2 in transverse alignment, occupying the center of the stigmal area; R_5 in direct longitudinal alignment with Rs; r–m short but distinct; cell 1st M_2 small, pentagonal, second section of M_{1+2} and basal section of M_3 subequal; m–cu before midlength of M_{3+4}; vein 2nd A bent slightly distad on outer fourth.

Abdomen pale green, more intense outwardly. Ovipositor with cerci slender, simple, gently upcurved to the acute tips; hypovalvæ darkened, the tips narrowly reddened.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, female, Enagotadi, altitude 1,800 meters, July 30, 1955 (*Gressitt*).

The most similar described regional species, *Limonia* (*Libnotes*) *fastosa* Alexander, differs in the coloration and in the details of wing venation.

LIMONIA (LIBNOTES) RUFULA sp. nov. Plate 1, fig. 6.

Size medium (wing of male 15 millimeters); rostrum yellow; mesonotal præscutum rufous, with three yellow stripes; posterior sclerites of notum pale, the mediotergite with a dark brown lateral spot; femora and tibiæ yellow, the tips narrowly dark brown; wings brownish yellow, very restrictedly patterned with brown; free tip of Sc_2 before the level of R_2; m–cu just before midlength of M_{3+4}; cell 2nd A narrow.

Male.—Length, about 11 millimeters; wing, 15.

Rostrum yellow; palpi yellow, outer segments darker. Antennæ with scape light yellow, pedicel obscure yellow, flagellum testaceous yellow; flagellar segments oval, the outer ones longer, verticils short. Head orange, the anterior vertex and narrow orbits light gray; anterior vertex very narrow, about equal in width to two rows of ommatidia.

Pronotum orange, narrowly infuscated on either side. Mesonotal præscutum with the restricted ground rufous, with three broad yellow stripes; sides of præscutum with an oval impressed brown area on extreme margin, with a pale brown cloud above the anterior spiracle; scutal lobes yellow, the broad central area and the scutellum pale testaceous yellow; mediotergite pale testaceous, with a conspicuous dark brown lateral spot on either side. Pleura deep yellow, paling to whitish yellow behind. Halteres with stem pale brown, knob dark brown. Legs with coxæ and trochanters yellow; femora and tibiæ yellow, tips narrowly dark brown; tarsi broken. Wings (Plate 1, fig. 6)

brownish yellow, very restrictedly patterned with brown, including barely indicated clouds at origin of Rs, fork of Sc, free tip of Sc_2 and R_2, best shown by a deepening in color of the veins; cord and outer end of cell 1st M_2 undarkened; veins light brown, C, Sc, R and most of Cu more yellowed. Venation: moderately long, Sc_1 ending about opposite midlength of cell 1st M_2, Sc_2 near its tip; free tip of Sc_2 far beyond level of R_2; cell 1st M_2 subequal to vein M_4; m–cu shortly before midlength of M_{3+4}, cell 2nd A narrow; anal veins convergent.

Abdomen, including hypopygium, dull orange, lateral tergal borders narrowly more darkened.

Habitat.—Northeast New Guinea.

Holotype, male, Karap, altitude 1,550 meters, July 20, 1955 (*Gressitt*).

The most nearly related species include forms such as *Limonia* (*Libnotes*) *ferruginata* Edwards, *L.* (*L.*) *termitina* (Osten Sacken) and *L.* (*L.*) *thwaitesiana* (Westwood) which, generally similar, differ in all details of coloration of the body, legs and wings.

LIMONIA (LIBNOTES) VIRIDICOLOR sp. nov. Plate 1, fig. 7; Plate 3, fig. 37.

Allied to *tayloriana;* general coloration of thorax light green, unpatterned; antennæ, legs and halteres tinged with green; wings faintly tinged with yellow, costa green; male hypopygium with the outer rostral spine of the male hypopygium long, gently curved.

Male.—Length, about 6 millimeters; wing, 7.

Rostrum relatively long and slender, about two-thirds the remainder of head; mouth-parts pale green; palpi brown, weakly tinged with green. Antennæ with scape and pedicel green, flagellum brown; flagellar segments passing into elongate, the verticils subequal to or a little longer than the segments, appressed. Head light gray; anterior vertex greatly reduced.

Thorax uniformly pale green, the color persistent in dead specimens. Halteres with stem pale green, knob small, weakly darkened. Legs with coxæ and trochanters pale green; remainder of legs tinged with green, the outer tarsal segments darker. Wings (Plate 1, fig. 7) faintly tinged with yellow, the costal vein light green, cells C and Sc greenish yellow; stigma pale brown, small and inconspicuous, unusually narrow; veins pale green, both ends of cell 1st M_2 slightly darker brown. Macrotrichia on veins beyond cord, lacking on Rs and the anal veins, excepting a single one near outer end of vein 2nd A.

Venation: Sc long; Rs relatively long, oblique, m–cu before midlength of M_{3+4}.

Abdomen, including hypopygium, light green. Male hypopygium (Plate 3, fig. 37) with the tergite, *t*, relatively narrow, the posterior border produced into two rounded lobes that are separated by a V-shaped notch, the lobes with several powerful bristles. Basistyle, *b*, relatively small, its total area less than half that of the ventral dististyle; ventromesal lobe obtuse at tip. Dorsal dististyle, *d*, a gently curved darkened rod, narrowed very gradually to the acute tip. Ventral style fleshy; rostral prolongation bearing two very unequal spines, the outer long and powerful, from a low darkened tubercle, the spine longer than the prolongation; inner spine less than one-third as long and very delicate. Gonapophysis, *g*, with the mesal-apical lobe long and slender, blackened, nearly straight, apex obtuse, margin with a few microscopic denticles. Ædægus, *a*, relatively slender, pale, the tip bilobed.

Habitat.—Northeast New Guinea.

Holotype, male, Goroka, altitude 1,700 meters, at light, June 25, 1955 (*Gressitt*).

The nearest relative is *Limonia* (*Libnotes*) *tayloriana* Alexander, which differs especially in the coloration and in the details of structure of the male hypopygium, as the much smaller rostral spine.

LIMONIA (DAPANOPTERA) GRESSITTIANA sp. nov.

Head dark brown; thorax brownish black; antennæ orange throughout; halteres light yellow; legs yellow, tips of femora and tibiæ blackened; wings yellow, restrictedly patterned with brown, including inconspicuous bands at origin of Rs, cord and over the outer crossveins; stigmal area circular, pure white; supernumerary crossvein in cell R_5 less than its own length beyond m; cell 1st M_2 long; abdomen black, segments two to six chiefly reddened.

Male.—Length, about 9 to 10 millimeters; wing, 14 to 15; antenna, about 2.5 to 2.6.

Female.—Length, about 8 to 9 millimeters; wing, 13 to 13.5.

Rostrum black, relatively long, about one-half the remainder of head; palpi brownish black. Antennæ orange throughout; flagellar segments oval, the terminal one elongate, its narrowed apex darkened; flagellar segments of male more strongly constricted at the incisures than in the female. Head dark gray; anterior vertex reduced to a capillary strip, subequal in width to a single row of ommatidia.

Thorax dark chocolate-brown to brownish black, virtually unpatterned, unusually glabrous. Halteres light yellow. Legs with the coxæ brownish black, fore trochanters testaceous, the remainder dark brown; femora yellow, tips narrowly but conspicuously black, tibiæ yellow, the tips more narrowly blackened; tarsi yellow, the outer two segments dark brown. Wings (Plate 1, fig. 8) yellow, restrictedly patterned with brown, including a darker band at origin of Rs, extended back to vein Cu; paler brown bands at cord and across the outer crossveins; outer radial field in cells R_2 and R_3 weakly suffused, forming a ring around the circular pure white stigmal spot; veins yellow, not or scarcely darker in the patterned areas. Venation: Sc ending just beyond the fork of Rs, Sc_2 near its tip; Rs long, arcuated; R_{1+2} and R_2 very pale to scarcely apparent, lying in the white stigmal spot; supernumerary crossvein in cell R_5 less than its own length beyond m; cell 1st M_2 long, gently widened outwardly, subequal in length to cell 2nd M_2; m–cu less than its own length beyond the fork of M.

Abdomen with basal segment black, segment two yellow, three to five, inclusive, usually reddish, in cases darkened, segment six reddish, darkened on central part; remainder, including hypopygium, black. Ovipositor with cerci small and weak, upcurved.

Habitat.—Northeast New Guinea.

Holotype, male, Mount Otto, above Kabebe, altitude 2,100 meters, June 24, 1955 (*Gressitt*). Allotype, female, Denglagu to Numbu, July 5, 1955 (*Gressitt*). Paratopotypes, 1 male, 1 female, June 23 to 24, 1955; paratype, 1 male, with the allotype.

This attractive fly is named for the collector, Dr. J. Linsley Gressitt. It is entirely distinct from other described species in the coloration of the body and wings. The most recent key to members of this subgenus is by the writer [Rec. South Australian Mus. 8 (1947) 588 to 589].

LIMONIA (DAPANOPTERA) VIRAGO Alexander.

Limonia (Dapanoptera) virago ALEXANDER, Ann. Mag. Nat. Hist. (13) 1 (1958) 661–662.

The types were from the Moss Forest Camp of the Third Archbold Expedition to New Guinea, altitude 2,800 meters, October 14 to 29, 1938 (*Toxopeus*).

Northeast New Guinea: Mount Otto, above Kabebe, altitude 7,250 feet, June 23, 1955 (*Gressitt*).

HELIUS (DELIUS) GOROKANUS sp. nov. Plate 1, fig. 9.

General coloration of thorax brown, the præscutum with three dark brown stripes, pleura brownish yellow, variegated with black spots; rostrum black; knobs of halteres infuscated; legs dark brown; wings faintly tinged with brown, stigma very pale brown; r–m short or obliterated by fusion of veins R_{4+5} and M_{1+2}; abdomen brown, the eighth sternite blackened.

Male.—Length, including rostrum, about 6.5 millimeters; wing, 6.5; rostrum, about 0.7.

Female.—Length, including rostrum, about 7 millimeters; wing, 6.8; rostrum, about 0.7.

Rostrum black, subequal in length to remainder of head; palpi black, conspicuous. Antennæ with pedicel black, remainder dark brown, nearly one-third longer than the rostrum; basal flagellar segment oval, the outer ones more elongate, exceeding the verticils. Head above gray, the center of vertex blackened.

Cervical region black. Pronotal scutum brown, scutellum more testaceous. Mesonotal præscutum with the sides broadly obscure yellow, the disk with three conspicuous dark brown stripes, interspaces yellowish brown; scutal lobes black, median region and posterior callosities obscure yellow; scutellum dark brown, the lower part, with the parascutella, yellow; mediotergite brown, paler laterally, pleurotergite yellow. Pleura brownish yellow, becoming pale yellow on the pteropleurite and metapleura; conspicuous shiny black areas before wing root, on anepisternum and on ventral sternopleurite, the last largest. Halteres with stem white, knob infuscated. Legs with coxæ brownish yellow to obscure yellow; trochanters similar, narrowly blackened at tips; remainder of legs dark brown. Wings (Plate 1, fig. 9) faintly tinged with brown, prearcular and costal fields somewhat clearer yellow; stigma long-oval, very pale brown; veins pale brown. Veins beyond cord, including Rs, with abundant macrotrichia. Venation: Sc ending about opposite midlength of Rs; r–m, when present, very short, in cases obliterated by fusion of veins R_{4+5} and M_{1+2}; cell 1st M_2 large, M_{3+4} about two-thirds M_1; m–cu a short distance beyond fork of M.

Abdominal tergites brown, sternites paler brown, the eighth sternite blackened; hypopygium light yellowish brown.

Habitat.—Northeast New Guinea.

Holotype, male, Goroka, altitude 2,000 meters, June 25, 1955 (*Gressitt*). Allotopotype, female.

The present fly is the first representative of the typical subgenus of *Helius* to be discovered in New Guinea. It is quite distinct from other Australasian species being more like certain Holarctic forms, as *Helius* (*Helius*) *longirostris* (Meigen) and *H.* (*H.*) *flavipes* (Macquart).

HELIUS (RHAMPHOLIMNOBIA) BIGEMINATUS sp. nov. Plate 1, fig. 10.

Belongs to the *papuanus* group; general coloration of thorax brownish black, præscutum with a broad line of yellow pollen on either side of the median area; wings whitish, with a heavy reticulated pattern, including four areas in cell R_3, these united behind to form two pairs; center of cell 1st M_2 with a circular ground spot.

Male.—Length, including rostrum, about 5.5 millimeters; wing, 5.5; rostrum, about 0.7.

Rostrum black, about one-third longer than remainder of head. Antennæ with scape and pedicel blackened; flagellum broken. Head brownish gray.

Cervical region black. Pronotum brownish black. Mesonotal præscutum and scutum dark cinnamon brown, the median stripe of the former broad, on neither side with a wide line of yellow pollen, extended backward to about two-thirds the length of the sclerite; scutellum and postnotum brownish black. Pleura brownish black, without distinct brightenings. Halteres with base of stem yellow, outwardly a little darker; knob broken. Legs with coxæ black; trochanters brownish black; remainder of legs broken. Wings (Plate 1, fig. 10) whitened, the prearcular and costal fields more brownish yellow; a very heavy reticulated brown pattern, arranged generally as in *fenestratus;* the chief darkened bands at cord and before origin of Rs entire, their centers a little paler than the margins; no darkening in cell R_1 before stigma; cell R_3 with four darkened areas arranged in pairs, these united behind along vein R_{4+5}; center of cell 1st M_2 with a circular ground spot. Coastal fringe of male relatively long. Macrotrichia on veins R_{4+5}, M_{1+2} and M_3. Venation: Cell R_3 at margin very extensive; distal section of Rs about two-thirds r–m; m–cu more than two-thirds its length before fork of M.

Abdomen brownish black, the posterior borders of sternites narrowly light gray pruinose.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, male, Enagotadi, altitude 1,800 meters, July 30, 1955 (*Gressitt*).

Although it is very similar in its general appearance to *Helius* (*Rhampholimnobia*) *fenestratus* Alexander, the present fly is distinct in the distribution of the darkened wing markings.

HELIUS (RHAMPHOLIMNOBIA) GRACILIROSTRIS sp. nov.

Male.—Length, including rostrum, about 5.5 to 5.6 millimeters; wing, 5 to 5.2; rostrum, about 1 to 1.2.

Female.—Length, including rostrum, about 6 millimeters; wing, 5.2.

In its general appearance the present fly is much like a small specimen of *Helius* (*Rhampholimnobia*) *subreticulatus* sp. nov., differing in some important features, additional to the small size.

Rostrum unusually long and slender, with conspicuous subappressed black setæ. Antennæ black, the basal segment of flagellum light yellow. Pale central line of mesonotal præscutum narrow or lost by approximation of narrow darker sublateral vittæ. Pleura dark brown, variegated with paler areas, including especially the dorsal pteropleurite and the dorsal and ventral sternopleurite. Halteres pale yellow. Femora with darkened ring more extensive and ill-delimited, the pale brown tip subequal in extent to the subterminal white ring. Wings with the costal fringe of male evidently shorter.

Habitat.—Northeast New Guinea.

Holotype, male, Karap, July 20, 1955 (*Gressitt*). Allotopotype, female. Paratopotype, 1 male.

HELIUS (RHAMPHOLIMNOBIA) MESOLINEATUS sp. nov.

Male.—Length, including rostrum, about 7.5 millimeters; wing, 6.5.

Characters generally as in *subreticulatus*, agreeing in the large size and in the general pattern of the wings, differing in the coloration of the legs and in the short costal fringe of the male. Antennæ with the scape and pedicel black, flagellum brown, the first segment light yellow. Head with anterior vertex restrictedly silvery, remainder of anterior vertex black, the area continued posteriorly to about midlength of the disk which otherwise is brownish gray.

Mesonotal præscutum conspicuously patterned, cinnamon brown on anterior half, darker brown posteriorly, with a

relatively broad gray central line that extends onto the midline of the scutum; lateral præscutal borders broadly more blackened; posterior sclerites of notum dark brown. Pleura and pleurotergite almost uniformly blackened, with vague more brownish gray areas. Halteres with stem obscure yellow, base of knob infuscated, apex obscure yellow. Legs with coxæ and trochanters brownish black; femora yellow, the outer third or more passing into black, with a narrow white ring just before the still narrower brown tip; tibiæ brownish black, the extreme tip white; tarsi yellow. Wings whitened, the prearcular and costal fields more yellowed; a clearly defined dark brown reticulated pattern, arranged much as in *subreticulatus*, including a marking in cell R beyond origin of Rs, and five darkened areas in cell R_3, these subequal in area to their interspaces. Costal fringe of male noticeably shorter than that of *subreticulatus*.

Abdomen brownish black, including the hypopygium; posterior borders of the tergites narrowly and vaguely silvery; sternites with paired silvery spots, as in some other species.

Habitat.—Northeast New Guinea.

Holotype, male, Kabebe, Mount Otto, altitude 2,100 meters, June 24, 1955 (*Gressitt*).

The most similar regional species include *Helius* (*Rhampholimnobia*) *gracilirostris* sp. nov. and *H.* (*R.*) *subreticulatus* sp. nov., especially the latter, as compared above. The most evident distinguishing characters include the coloration of the pleura, halteres and legs, and the short costal fringe of the wing.

HELIUS (RHAMPHOLIMNOBIA) PAPUANUS Alexander.

Helius (*Rhampholimnobia*) *papuanus* ALEXANDER, Philip. Jour. Sci. 54 (1934) 324–326, plate 1, fig. 12 (venation), plate 3, fig. 35 (♂ hypopygium).

Described from New Britain and Northeast New Guinea.

Northeast New Guinea: Busu, September 15, 1955 (*Gressitt*).

HELIUS (RHAMPHOLIMNOBIA) SIMULATOR sp. nov.

Male.—Length, including rostrum, about 5.3 to 5.5 millimeters; wing, 4.8 to 5; rostrum alone, about 0.7 to 0.8

Generally similar to *Helius* (*Rhampholimnobia*) *papuanus* Alexander, differing in details of coloration of the body, legs and wings. Both species have the darkened wing pattern relatively narrow, much less extensive than the ground; no darkening in cell R_1 beyond origin of Rs; two darkened areas

in cell R_3, narrower than the interspaces; darkened crossband before origin of Rs not parallel-sided as in *fenestratus* Alexander and *guttulinus* Alexander, the area in cell M lying distinctly basad of those in cells R and 1st A, thus forming a narrow irregular band.

Pronotum and anterior end of præscutum obscure yellow, the posterior sclerites of mesonotum darker. Knobs of halteres light yellow. Tips of femora uniformly yellow, with a weak darkening at or just before apex, the extreme tip not blackened, as in *papuanus;* tibiæ dark brown, the extreme base and tip yellowed. Wings with costal fringe of male slightly longer than in *papuanus;* dark pattern less extensive than the white interspaces, the latter with faintly darkened centers that are encircled by the white ground, this condition somewhat as in the otherwise distinct *guttulinus.*

Habitat.—Northeast New Guinea.

Holotype, male, Korip, July 12, 1955 (*Gressitt*). Paratopotypes, 3 males.

IDELIUS (RHAMPHOLIBINOBIA) SUBRETICULATUS sp. nov. Plate 1, fig. 11.

Size large (wing about 6.5 millimeters); mesonotum yellow to reddish brown, the præscutum with a pale central vitta that is continued backward to the scutellum; pleura uniformly dark brown; halteres light yellow; femora yellow with a broad dark subterminal ring, the apex bicolored, including an internal brown ring and a white subterminal annulus; wings pale yellow with a conspicuous brown reticulated pattern; costal fringe of male long; abdomen dark brown, the posterior border of tergites narrowly silvery, each of the sternites with a pair of silvery spots at posterior border; hypopygium yellow to fulvous yellow.

Male.—Length, including rostrum, about 5.8 to 6 millimeters; wing, 6.5 to 7; rostrum, about 1 to 1.2.

Female.—Length, about 6.8 to 7 millimeters; wing, 6.3 to 6.5.

Rostrum black, relatively long, as shown by the measurements; mouth-parts yellow. Antennæ shorter than the rostrum; scape and pedicel black, flagellum brown; flagellar segments oval, shorter than the verticils. Head with front and fore part of anterior vertex light gray, posterior vertex darker gray; narrowest part of anterior vertex blackened, narrow, less than the diameter of scape.

Cervical region brownish black. Pronotum light brown. Mesonotum yellow to reddish brown, the præscutum more yellowed

anteriorly, with a narrow pale median vitta that extends back to the scutum; scutellum and mediotergite dark brown. Pleura uniformly dark brown. Halteres light yellow. Legs with coxæ dark brown; trochanters testaceous yellow; femora yellow with a broad dark brown ring before apex, the latter bicolored, the extreme tip obscure yellow, with an internal indistinct brown ring and a narrow clear white subterminal annulus; tibiæ and tarsi yellow. Wings (Plate 1, fig. 11) pale yellow, costal field more brownish yellow; a conspicuous reticulated brown pattern, arranged somewhat as in *reticulatus;* cell R_3 with three or four brown dashes, cell R_1 with a single such line; veins brownish yellow, darker in the patterned areas. Costal fringe of male long and conspicuous; anterior branch of Rs without macrotrichia. Venation: Branches of Rs widely divergent, cell R_2 narrow at margin; m–cu before the fork of M.

Abdomen dark brown, tergites with posterior borders narrowly silvery; each sternite with a pair of silvery spots at posterior margin; male hypopygium yellow to fulvous yellow.

Habitat.—Widely distributed in New Guinea.

Holotype, male, Enagotadi, Netherlands New Guinea, altitude 2,000 meters, August 5, 1955 (*Gressitt*). Allotopotype, female, pinned with type. Paratopotypes, males and females, with the types; paratypes, males and females, Obano, Netherlands New Guinea, August 9, 1955; Itouda and Okaitadi, August 1955; males and females from Northeast New Guinea, including Daulo Pass, altitude 2,400 meters, June 13, 1955; Kabebe, Mount Otto, altitude 2,100 meters, June 21, 1955 (*Gressitt*); males and females from Mount Dayman, Maneau Range, Papua, altitude 1,550 to 2,330 meters, May 17 to July 13, 1953 (*Geoffrey M. Tate*); Archbold IV Collection.

The most similar regional species include *Helius* (*Rhamphol imnobia*) *gracilirostris* sp. nov. and *H.* (*R.*) *mesolineatus* sp. nov., described herewith. In the long conspicuous costal fringe of the male it is similar to *H.* (*R.*) *papuanus* Alexander, distinguished by the large size, and in the coloration of the body, legs and wings. This evidently is the commonest and most widely distributed member of the subgenus so far discovered in New Guinea.

HEXATOMINI

EPIPHRAGMA (EPHIPHRAGMA) RISORIA sp. nov. Plate 1, fig. 12; Plate 3, fig. 38.

Size medium (wing of male 10 millimeters); mesonotal præscutum light brown, patterned with dark brown and yellow;

antennæ bicolored; halteres yellow; femora brownish yellow, with a vague darker subterminal ring; wings yellow, conspicuously patterned with brown, the costal dark areas with paler centers; r–m shortly before fork of Rs; m very long, more than one-half longer than the transverse basal section of M_3; m–cu before midlength of cell 1st M_2; male hypopygium with the tergal lobes low, blackened; basistyle slender, with a finger-like lobe on mesal face beyond midlength; inner dististyle with a conspicuous lobe on lower margin near base.

Male.—Length, about 10 millimeters; wing, 10; antenna, about 3.2.

Female.—Length, about 10 millimeters; wing, 10.

Rostrum black; palpi brownish black. Antennæ of male long, as shown by the measurements; yellow, the bases of the second and succeeding flagellar segments darkened to produce a bicolored appearance, the amount of dark increasing slightly on the outer segments; segments longer than their verticils, surface with abundant groups of microscopic setulæ. Head brownish gray, paler behind; anterior vertex moderately broad, nearly twice the diameter of scape.

Pronotum yellow. Mesonotal præscutum light brown in front, conspicuously dark brown on sides, with an intermediate pair of short paler brown stripes before suture, the interspaces more yellowed, the lateral one extended across the suture onto the lateral part of scutal lobe; remainder of scutal lobes dark brown; scutellum testaceous yellow, parascutella brownish black; postnotum dark brown; vestiture of præscutal interspaces sparse but long and conspicuous. Pleura chiefly dark brown, the dorsal sternopleurite and membrane surrounding the anterior spiracle yellowed. Halteres elongate, yellow. Legs with the coxæ yellow, fore pair more brownish yellow; trochanters obscure yellow; femora brownish yellow, brighter at base, darkening to a vague subterminal ring, apex yellow; tibiæ and tarsi brownish yellow, outer tarsal segments dark brown. Wings (Plate 1, fig. 12) yellow, the prearcular and costal fields more saturated yellow; a conspicuous brown pattern, as follows: Region of arculus, extending into cell C; origin of Rs, extended backward, continued as a narrow seam over M, connected with a broad oblique band that extends from the stigma to vein M; major marginal areas at ends of all longitudinal veins, smallest on R_5, these areas with slightly paler centers; other small darkenings at outer end of cell 1st M_2, fork of M and along

posterior border of cell 2nd A; narrow dusky seams over veins R_5, Cu and 1st A; veins yellow, darker in the clouded areas. Venation: Supernumerary crossvein in cell C weak; Sc_2 elongate; r–m shortly before fork of Rs; cell M_1 deep, more than twice its petiole; m elongate, longitudinal in position, more than one-half longer than the transverse basal section of M_3; m–cu before midlength of cell 1st M_2.

Abdominal tergites brownish yellow, the transverse impressed lines concolorous and inconspicuous; sternites brownish yellow, very narrowly bordered by darker. Male hypopygium (Plate 3, fig. 38) with the tergite narrowed outwardly, posterior border with two low blackened lobes that are separated by a very shallow V-shaped notch; surface back from margin with abundant strong setæ that are directed caudad. Basistyle, *b*, slender, with a conspicuous fingerlike lobe on mesal face beyond midlength. Dististyles, *d*, terminal; outer style broad, narrowed gradually into a slender point, its surface microscopically roughened; inner style more slender, the apex narrowed to a point, separated from a lower subapical tooth by a rounded notch; lower margin of style with a conspicuous lobe that is tipped with long delicate setæ. Gonapophysis appearing as a slender curved hook. Ædeagus relatively short, broad-based.

Habitat.—Northeast New Guinea.

Holotype, male, Mount Otto, altitude 2,100 to 2,000 meters, June 22, 1955 (*Gressitt*). Allotopotype, female.

Epiphragma (*Epiphragma*) *risoria* is entirely distinct from the other previously described regional members of the subgenus, differing in the pattern and venation of the wings and in the coloration of the legs. Such species include *E.* (*E.*) *fuscodiscalis* Alexander, *E.* (*E.*) *fuscoterminalis* Alexander, and *E.* (*E.*) *gloriola* Alexander.

AUSTROLIMNOPHILA (AUSTROLIMNOPHILA) CROCEIPENNIS sp. nov. Plate 1, fig. 13.

Mesonotum chiefly light grayish brown, without distinct stripes, anterior third of præscutum brown, the color continued backward over the sides and beneath the wing root; legs yellow; wings pale yellow, with a restricted medium brown pattern.

Sex?—Wing, about 12 millimeters.

Rostrum light brown; palpi brownish yellow. Antennæ with scape brownish yellow, pedicel yellow; basal segments of flagellum yellow, the bases narrowly darkened; outer segments broken. Head dark gray, narrowly yellowed behind. Ante-

rior vertex narrow, about one-half the diameter of scape or about equal to three rows of ommatidia.

Pronotum obscure yellow. Mesonotum chiefly light grayish brown, without distinct stripes; anterior third of præscutum brown, the pattern continued backward over the sides, passing beneath the wing root as a broad diffuse stripe; posterior sclerites of notum ashy gray. Pleura brownish yellow, darkened dorsally, as described. Halteres with stem yellow, knob broken. Legs with coxæ and trochanters reddish yellow; femora and tibiæ yellow; tarsi broken. Wings (Plate 1, fig. 13) pale yellow, the prearcular and costal fields more saturated; a restricted medium brown pattern, as follows: At arculus, origin of Rs, stigma and cord, R_2 and adjoining veins, and as marginal areas, largest of 2nd A, lacking on R_5; still fainter seams over m-cu, outer end of cell 1st M_2, fork of M_{1+2}, a darkening along vein Cu in cell M, and in the axillary area; veins yellow, slightly darker in the patterned areas. Small macrotrichia on veins of outer half or more of wing, lacking on basal half of Rs, Cu and vein 2nd A, appearing as very sparse series on M and outer end of vein 1st A. Venation: Rs square and angulated at origin; R_{2+3+4} about twice the basal section of R_5; cell M_1 nearly twice its petiole; m-cu at near two-thirds the length of M_{3+4}.

Abdominal tergites brownish yellow, sternites more testaceous yellow.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, sex?, Okaitadi, altitude 1,800 meters, August 8, 1955 (*Gressitt*).

Readily told from the now numerous species of the genus known from New Guinea by the coloration of the wings, in conjunction with the pattern of the thorax and legs.

AUSTROLIMNOPHILA (AUSTROLIMNOPHILA) EUCHARIS sp. nov.

Plate 1, fig. 14; Plate 3, figs. 39, 40.

Size medium (wing about 11 millimeters); general coloration of thorax brown, patterned with paler; antennal flagellum bicolored; halteres elongate, pale yellow; femora conspicuously patterned dark brown and yellow, the basal half chiefly darkened; wings pale yellow, patterned with brown, including dark markings along the veins; male hypopygium large, upper tergal lobes simple, pale; basistyle at apex produced into a very large flattened blade; dististyles relatively small, the outer one slender.

Male.—Length, about 9 millimeters; wing, 11.5.

Female.—Length, about 10 millimeters; wing, 10.5.

Rostrum and palpi black. Antennæ with scape, pedicel and first flagellar segment yellow, succeeding segments bicolored, narrowly blackened at base, the outer ends yellow; flagellar segments elongate (flagellum broken in type). Anterior vertex blackened, pruinose; posterior part of vertex and occiput chestnut brown, genæ brownish black; anterior vertex in male relatively narrow, a little less than the diameter of the scape.

Pronotum brown. Mesonotal præscutum brownish gray laterally behind, the central area with a broad brown stripe that is more or less interrupted at near midlength; humeral and lateral borders broadly brown; scutum light gray, the center of each lobe dark brown; scutellum brownish testaceous; mediotergite brown, heavily gray pruinose, more infuscated posteriorly, pleurotergite light brown. Pleura dark brown, with a broad pale area on the dorsal sternopleurite, in the female the whole sternopleurite pale; dorsopleural membrane dusky, yellow surrounding the anterior spiracle. Halteres elongate, pale yellow. Legs with the coxæ and trochanters yellow; femora conspicuously patterned, broadly dark brown beyond base, followed by a narrower yellow ring and a still narrower brown annulus, the narrow tip pale; tibiæ yellow, tips narrowly darkened; tarsi brownish yellow, outer segments infuscated; intermediate setæ modified into long slender scales. Wings (Plate 1, fig. 14) pale yellow, the costal border more saturated yellow; a conspicuous brown pattern, including large and smaller areas over most of wing, least so in costal field; the larger markings are marginal, being especially conspicuous in cell 2nd A; other large areas beyond arculus and over the anterior cord and stigmal region; smaller seams at origin of Rs, posterior cord and outer end of cell 1st M_2; scattered spots over the veins, mostly separate but some more confluent; veins yellow, infuscated in the patterned areas. Macrotrichia on veins of outer two-thirds of wing, lacking on 2nd A. Venation: Cell M_1 more than twice its petiole; m–cu at near two-thirds the length of cell 1st M_2.

Abdomen obscure yellow to brownish yellow, the outer segments brown in the male. Male hypopygium (Plate 3, figs. 39, 40) of the general type of *multitergata*, differing in all details. Ninth tergite, *t*, with the dorsal lobes pale, simple, fingerlike, provided with dense setulæ and scattered bristles; lower lobes bifid, heavily blackened at tips. Basistyle, *b*, produced at apex into a very large flattened blade, at its base with a concen-

tration of long setæ; mesal face of style with a darkened corrugated area. Dististyles, *d*, relatively small, the outer slender, its tip acute, on outer margin near base with a small tubercle; inner style longer and broader, at base on lower face with a toothlike flange. Phallosome, *p*, large; ædæagus broad, apex slightly trilobed; gonapophyses as shown.

Habitat.—Netherlands New Guinea (Wisselmeren area).

Holotype, male, Itouda, altitude 1,500 meters, August 13, 1955 (*Gressitt*). Allotopotype, female.

The most similar regional species include *Austrolimnophila* (*Austrolimnophila*) *multitergata* sp. nov. and *A.* (*A.*) *polydamas* Alexander, both of which have the wing pattern somewhat the same. The present fly is readily told by the medium size, conspicuously patterned femora and by the structure of the male hypopygium, which is quite different from that of *multitergata*. The male of *polydamas* is still unknown.

AUSTROLIMNOPHILA (AUSTROLIMNOPHILA) MULTITERGATA sp. nov.

Plate 1, fig. 15; Plate 3, figs. 41, 42.

Size medium (wing of male 9 millimeters); general coloration of mesonotal præscutum and scutum buffy yellow, the posterior sclerites of notum and much of the pleura dark brown; antennæ of male elongate, flagellar segments bicolored; legs obscure yellow; wings pale yellow, conspicuously patterned with brown, including series of more or less confluent spots on most of the veins; m-cu lying far distad; male hypopygium large, the tergite produced into two pairs of blackened lobes, all emarginate at tips, the outer face of upper pair with strong setæ; basistyle with a spinelike blade on mesal face near apex; dististyles large, the inner one larger; ædæagus small, broadly expanded at base.

Male.—Length, about 10 millimeters; wing, 9; antenna, about 4.5.

Rostrum and palpi black. Antennæ of male elongate, approximately one-half the wing; scape and pedicel light yellow, flagellar segments bicolored, the bases dark brown, apices yellow, on the proximal segments the two colors subequal in amount, the amount of yellow decreasing on the outer segments but persistent to the end; flagellar segments elongate-cylindrical, much longer than the verticils; remaining vesture short but very abundant, the microscopic setulæ arranged in chiefly transverse palmate groups. Head dark brownish gray, the occipital region paling to brown; anterior vertex narrow, approximately one-half the diameter of scape.

Pronotum buffy yellow. Mesonotal præscutum and scutum buffy yellow, the former darkened on lateral border, the latter on mesal part of each lobe; posterior sclerites or notum more infuscated, sparsely pruinose. Propleura light yellow; mesopleura infuscated, more heavily so dorsally; metapleura and meron paler. Halteres with stem light yellow (knob broken). Legs with coxæ and trochanters obscure yellow; femora obscure yellow, unpatterned; remainder of legs yellow, the outer tarsal segments weakly darkened; interpolated linear scales only slightly differentiated from the normal setæ. Wings (Plate 1, fig. 15) pale yellow, the prearcular and costal fields more saturated; a conspicuous brown pattern, including costal areas at arculus, origin of Rs, tip of Sc and fork of R_{2+3+4} tip of R_{1+2}, and end of vein R_3; narrower seams over cord and outer end of cell 1st M_2; series of circular spots on most longitudinal veins, these more or less confluent, smaller and more sparse on M; veins yellow, slightly darker in the patterned areas. Abundant macrotrichia on virtually all veins except near and before arculus. Venation: Sc long, Sc_1 ending beyond fork of R_{2+3+4}, Sc_2 near its tip; R_{1+2} about one-half longer than R_2; Rs short, arcuated at origin; R_{2+3+4} about three-fourths R_3; cell 1st M_2 long, with m–cu at near three-fourths to four-fifths the length; cell M_1 nearly twice its petiole; cell 2nd A narrow.

Abdomen with conspicuous setæ, light brown, the extreme posterior borders of the tergites paler, of the sternites more broadly so; hypopygium large, dark brown. Male hypopygium (Plate 3, figs. 41, 42) as viewed from the side with the tergite and sternite partly fused, the tergal region, *t*, with heavily blackened armature, including a pair of smaller erect dorsal blades that are notched at tips and two larger ventral plates that are similarly emarginate at tips; lower or posterior face of dorsal blades with long conspicuous erect setæ. Basistyle, *b*, with a strong spinelike blade on mesal face near apex. Dististyles, *d*, with outer style smaller, bearing a small setuliferous lobule on outer margin at near midlength, the extended body of style glabrous, gradually narrowed to the tip; inner style a large flattened blade, the expanded disk with scattered erect setæ, lower margin blackened. Phallosome, *p*, with the ædeagus very small, broad-based; gonapophysis irregular in outline, the main part a slender rod, bent at an acute angle, the tip obliquely truncate.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, male, Okaitadi, altitude 1,760 meters, August 7, 1955 (*Gressitt*).

The most similar described regional species include *Austrolimnophila* (*Austrolimnophila*) *cyclopica* Alexander, *A.* (*A.*) *polydamas* Alexander, and *A.* (*A.*) *eucharis* sp. nov., all of which differ among themselves in the coloration of the body, legs and wings, and, where known, in the structure of the male hypopygium. In the present fly the tergal development of the hypopygium is peculiar and noteworthy.

AUSTROLIMNOPHILA (AUSTROLIMNOPHILA) NEBRIAS sp. nov.

Plate 1, fig. 16; Plate 3, fig. 44.

Size medium (wing of male 11 millimeters); mesonotum light brownish gray, the anterior end of præscutum dark brown, the color continued backward along sides of mesonotum to the abdomen; antennæ uniformly yellow to pale brown; femora yellow on central part, brown basally and at apex, tibiæ and tarsi yellow; wings very pale yellow, with a restricted brown pattern, including large circular marginal spots on all veins excepting R_5 and M_1; anterior cord oblique, inner end of cell 1st M_2 arcuated, m–cu at near three-fifths the length of cell 1st M_2; male hypopygium with the tergite terminating in two blackened lobes; outer dististyle with the body very high, obtuse, inner style expanded at outer end.

Male.—Length, about 11 millimeters; wing, 11; antenna, about 4.

Rostrum and palpi yellow. Antennæ yellow basally, the outer flagellar segments passing into very pale brown; segments much longer than the inconspicuous verticils, clothed with a dense white pubescence (outer segments broken). Head dark gray, occiput paling to light brown; anterior vertex very narrow, about equal to one and one-half rows of ommatidia or about one-fifth the diameter of the scape.

Pronotum yellow. Mesonotum almost uniformly light brownish gray, the anterior and lateral parts of the præscutum conspicuously brown, the color continued backward over the dorsopleural region, including the dorsal pteropleurite and lower pleurotergite, to the abdomen. Pleura light gray, propleura and dorsopleural region yellow, ventral sternopleurite slightly darkened. Halteres elongate, pale yellow. Legs with the coxæ yellow, sparsely whitish pruinose; trochanters yellow; femora brownish basally and at apex, fore pair more uniformly

darkened; tibiæ and tarsi yellow. Wings (Plate 1, fig. 16) very pale yellow, with a restricted brown pattern, the larger areas at stigma, origin of Rs, and as circular marginal spots at ends of the longitudinal veins, lacking on R_5 and M_1, only slightly larger on the anal veins; further smaller areas at arculus, cord, outer end of cell 1st M_2 and fork M_{1+2} veins yellow, darkened in the patterned areas. Small macrotrichia on virtually all veins. Venation: Sc long, Sc_1 ending beyond level of outer end of cell 1st M_2, Sc_2 at its tip; R_{1+2} about twice R_2; anterior cord oblique, inner end of cell 1st M_2 arcuated; R_{2+3+4} about twice the basal section of R_5; cell M_1 deep, nearly three times its petiole; m–cu at near two-thirds the length of M_{3+4}.

Abdominal tergites medium brown, the outer segments darker; basal sternites light yellow; hypopygium large, slightly darkened. Male hypopygium (Plate 3, fig. 44) with the tergite, *t*, narrowed outwardly, terminating in two blackened lobes, their tips obtusely rounded. Basistyle, *b*, slender, with a small flattened spine on mesal face before tip. Dististyles, *d*, two, the outer one very high crested, the beak slender, its tip slightly decurved; inner style with the slender base blackened, outer half expanded into a subrectangular blade. Phallosome, *p*, massive blackened basally; ædeagus slender; gonapophysis a strongly curved hook.

Habitat.—Northeast New Guinea.

Holotype, male, Kabebe, Mount Otto, altitude 2,100 meters, June 23, 1955 (*Gressitt*).

The most similar regional species include *Austrolimnophila* (*Austrolimnophila*) *cyclopica* Alexander and *A.* (*A.*) *flaxa* Alexander, distinguished among themselves by the pattern of the legs and wings, the details of venation, and, where known, by the structure of the male hypopygium.

PARALIMNOPHILA (PAPUAPHILA) DELECTA sp. nov. Plate 1, fig. 17.

General coloration of mesonotal præscutum and scutum chestnut brown, the posterior sclerites dark brown; antennal flagellum yellow; halteres whitened; wings whitened, with a conspicuous brown pattern; male hypopygium with the central plate of the tergite shield-shaped, narrowed posteriorly.

Male.—Length, about 12 millimeters; wing, 10; antenna, about 1.5.

Rostrum black, gray pruinose; palpi black. Antennæ of male short, 13-segments; scape and pedicel brownish black, flagellum yellow, outer segments darker; flagellar segments suboval,

shorter than the longest verticils; terminal segment about one-half longer than the penultimate. Head dull black, gray pruinose; anterior vertex broad, about three times the diameter of the scape.

Pronotum dark brown. Mesonotal præscutum chiefly chestnut brown, representing four stripes that are separated by vague darker interspaces, the central vitta narrow; pseudosutural foveæ reddish, inconspicuous against the ground; scutal lobes dark chestnut brown; scutellum and postnotum dark liver brown. Pleura dark brown dorsally, the ventral and posterior parts paler brown. Halteres whitened. Legs with coxæ and trochanters brown; remainder of legs broken. Wings (Plate 1, fig. 17) whitened, with a conspicuous brown pattern that includes most of cell C, areas at origin of Rs, over Sc_2 and a major oblique marking extending from the stigma to cell 1st M_2; a second large darkening at outer end of cell R_3, involving parts of cell R_2 and especially R_4; further darkenings at arculus, over the cord, outer end of cell 1st M_2, fork of M_{1+2}, and tips of veins M_1, M_2 and M_3; still further but more diffuse clouds over M, at midlength of cells M and Cu, outer end of cell M_4 and including most of cell 2nd A; veins yellow, infuscated in the patterned areas. Macrotrichia on veins beyond the cord, as far basad as M_3. Venation: Sc_1 ending just before fork of R_{2+3+4}, Sc_2 long, a little shorter than $_{2+3+4}$; cell M_1 slightly shorter than its petiole; cell 1st M_2 relatively short, gently widened outwardly, with m–cu at near one-third the length; vein 2nd A relatively long, gently sinuous, ending distinctly before the level of origin of Rs.

Abdomen brownish black. Male hypopygium (Plate 3, fig. 45) with the central plate of the tergite shield shaped, strongly narrowed behind. Outer dististyle, *d*, with the terminal spine acute.

Habitat.—Northeast New Guinea.

Holotype, male, Nondugl, Ahl Valley, July 8, 1955 (*Gressitt*).

Other regional species of the subgenus having patterned wings include *Paralimnophila* (*Papuaphila*) *decorata* Alexander and *P.* (*P.*) *euryphæa* Alexander, differing from the present fly in the coloration of the body and wings.

PARALIMNOPHILA (PAPUAPHILA) EURYPHÆA (Alexander).

Gynoplistia (*Paralimnophila*) *euryphæa* Alexander, Ann. Mag. Nat. Hist. (11) 13 (1946) 751–753.

The type was from Mount Tafa, Papua, altitude 8,500 feet, taken in February 1934 (*Chessman*).

Northeast New Guinea: Mount Wilhelm, altitude 2,700 meters, July 4, 1955 (*Gressitt*).

PARALIMNOPHILA (PAPUAPHILA) HOLOXANTHA sp. nov. Plate 1, fig. 18.

Size relatively large (wing of female 11.5 millimeters); general coloration of body yellow, pronotum and anterior half of præscutum with a central brown stripe, sublateral præscutal stripes and centers of scutal lobes paler brown; wings brownish yellow, very restrictedly patterned with brown; cell M_1 present; abdomen uniformly yellow.

Female.—Length, about 12 millimeters; wing, 11.5.

Rostrum dark brown; palpi brown basally, outer segments blackened. Antennæ with scape and pedicel testaceous yellow (flagellum broken). Head with the anterior vertex behind the antennal fossæ dull pruinose, the remainder of head black, subnitidous, the narrowed occipital region a trifle more reddened; anterior vertex broad, more than four times the diameter of the scape.

Prothorax yellow, with a broad light brown central area, narrowed and more blackened on the anterior constricted part of the scutum. Mesonotal præscutum light yellow, restrictedly patterned with darker, including a central brown stripe that narrows behind, ending at near midlength of the sclerite; sublateral stripes narrow, much paler; pseudosutural foveæ subtriangular, reddish brown; posterior sclerites of notum light yellow, each lobe with a very pale brown area, this being a posterior extension of the sublateral præscutal area. Pleura yellow; dorsopleural region weakly darkened; anterior spiracle large, transverse. Halteres with stem obscure yellow, knob darkened. Legs with coxæ and trochanters pale yellow; remainder of legs obscure yellow (broken beyond midlength of tibia). Wings (Plate 1, fig. 18) brownish yellow, cell Sc deeper yellow; a very restricted to scarcely evident dark pattern, including brown clouds at origin of Rs, cord, stigma, tip of vein R_3, outer end of cell 1st M_2 and fork of M_{1+2}; centers of basal cells, R_1 and M_4 more hyaline; veins brownish yellow, darker in the patterned parts. Macrotrichia on veins beyond cord as far basad as M_1, lacking on R_3, R_{2+3} and M_3, with a few scattered trichia near outer end of M_2; a series of longer trichia on basal third of vein R. Venation: R_{2+3+4} less than one-half the arcuated basal section of R_5; cell M_1 about one-half longer than its petiole; cell 1st M_2 small, m short; m–cu at near one-third the length of M_{3+4}; vein 2nd A short, very gently sinuous.

Abdomen yellow, including the general shield.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, female, Okaitadi, altitude 1,800 meters, August 8, 1955 (*Gressitt*).

Paralimnophila (*Papuaphila*) *holoxantha* is most similar to species such as *P.* (*P.*) *angusticincta* Alexander, *P.* (*P.*) *apicalis* (de Meijere), *P.* (*P.*) *contingens* (Walker) and *P.* (*P.*) *fusco-abdominalis* Alexander, differing in the general yellow coloration of the body, excluding the blackened vertex.

PARALIMNOPHILA (PAPUAPHILA) PERDIFFUSA sp. nov. Plate 2, fig. 19.

Size medium (wing 9 millimeters); thorax orange yellow, pronotum with a central cinnamon brown line that is continued backward onto the præscutum, lateral præscutal stripes cinnamon brown; head with posterior half polished black; legs black, femora vaguely patterned; wings brownish yellow, with a very diffuse darker brown pattern that includes clouds over origin and fork of Rs; cells C and Sc uniformly dark brown; macrotrichia lacking on vein M; cell M_1 present; cell 2nd A narrow.

Sex?—Wing, 9 millimeters.

Rostrum brownish black; palpi black. Antennæ with scape and pedicel dark brown (flagellum broken). Head with front and anterior vertex light gray pruinose, posterior vertex and occiput polished black; anterior vertex behind the antennal fossæ indistinctly trilobed, about five times as wide as the diameter of scape.

Thorax orange yellow; pronotum with a central cinnamon brown line that is continued backward onto the præscutum, not quite reaching the suture, more intensely darkened at the midline; lateral præscutal stripes cinnamon brown, crossing the suture onto the scutal lobes; pseudosutural foveæ dark brown, oval, shining; posterior sclerites of notum and the pleura orange-yellow, unpatterned. Halteres brownish black (knob broken). Legs with coxæ and trochanters orange; remainder of legs black, the extreme femoral bases more or less yellowed; a vague brightening before the tip of the femur. Wings (Plate 2, fig. 19) brownish yellow, with a very diffuse darker brown pattern, including major clouds over origin and fork of Rs, with narrower seams at posterior cord, outer end of cell 1st M_2, stigma and outer end of vein R_3; cells C and Sc uniformly dark brown; veins brown, relatively stout and conspicuous. Macrotrichia of outer veins more restricted than in other similar species, lacking on Rs, basal section of R_5 and M. Venation:

Rs relatively short; cell M_1 more than one-half longer than its petiole; m-cu about opposite one-fourth the length of cell 1st M_2; vein 2nd A unusually short, the cell narrow.

Abdomen broken.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, sex?, Obano, August 9, 1955 (*Gressitt*).

The most similar described regional species include *Paralimnophila* (*Papuaphila*) *angusticincta* Alexander and *P.* (*P.*) *fuscoabdominalis* Alexander which are well distinguished by the unpatterned wings, with the costal region concolorous with the remainder of the ground, and with the macrotrichia or the veins more numerous.

GYNOPLISTIA (GYNOPLISTIA) ALBIZONATA Alexander.

Gynoplistia (*Gynoplistia*) *albizonata* Alexander, Philip. Jour. Sci. 66 (1938) 236–237, Plate 1, fig. 9 (venation).

The type was from Mount Misim, Morobe District, Northeast New Guinea, altitude 6,400 feet, taken in March.

Northeast New Guinea: Above Kabebe, Mount Otto, at light, June 24, 1955 (*Gressitt*).

GYNOPLISTIA (GYNOPLISTIA) JOCOSA sp. nov. **Plate 2, fig. 20; Plate 3, fig. 46.**

Belongs to the *jucunda* group; head and thorax fulvous orange, basal segments of abdomen orange yellow, segments seven to nine black; antennæ of male 16-segmented, with ten long branches; halteres yellow; femora yellow, tips broadly black, tibiæ and tarsi black; wings yellow, with a restricted dark brown pattern, the apex broadly paler brown; basistyle of male hypopygium without apical lobes, dististyle black, the narrowed tip with a few conspicuous setæ; phallosome with the gonapophyses decussate at midlength, each with about four apical spines or denticles; lateral arm of phallosome very compact, black.

Male.—Length, about 6 millimeters; wing, 6.

Rostrum and palpi orange. Antennæ of male broken and detached on point; 16-segmented, formula $_{2+2+8+4}$; scape, pedicel and proximal two flagellar segments fulvous, remainder of organ, including all branches, black; longest branch (about flagellar segment five) somewhat less than one-half the entire flagellum; last branch shorter than the segment; outer unbranched segments subequal in length. Head fulvous orange; anterior vertex broad.

Thoracic notum uniformly fulvous orange; præscutal vestiture pale, short and abundant; pleura more clearly orange.

Halteres yellow. Legs with coxæ and trochanters light orange; femora yellow, the tips broadly and conspicuously black; tibiæ and tarsi black. Wings (Plate 2, fig. 20) with the ground yellow, the prearcular and costal fields more saturated; dark brown areas at origin of Rs and along the cord, the latter including the stigma, narrowed posteriorly but virtually crossing the wing; wing tip broadly paler brown; a small darkened cloud at arculus; outer end of cell 1st M_2 narrowly darkened; veins light brown, in the prearcular field still paler, in the more heavily darkened areas darker brown. Conspicuous macrotrichia on veins R_{2+3+4}, R_3, R_4, R_5 and a scattered series on M_{1+2}. Venation: Sc ending opposite fork of Rs; veins R_5 and R_4 strongly divergent, cell R_3 very broad at margin; cell M_1 lacking.

Abdomen with basal segments clear orange yellow, segments seven to nine, together with the outer half of the sixth tergite, black. Male hypopygium (Plate 3, fig. 46) with tergite transverse, the posterior border broadly convex. Basistyle, *b*, without apical lobes, the dististyle thus strictly terminal in position; mesal face of style with conspicuous elongate setæ. Dististyle, *d*, black, broad on basal three-fourths, the slender outer part with the ædeagus small, constricted at near midlength; gonapophysis appearing as a stout rod with about four apical spines or denticles, the apophyses decussate at the midline; lateral arm of phallosome very compact, black, produced at apex into an acute spine.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, male, Okaitadi, altitude 1,800 meters, August 8, 1955 (*Gressitt*).

This distinct fly has no very similar ally, the most so being *Gynoplistia* (*Gynoplistia*) *lieftinckiana* Alexander, which differs in the pattern of the wings and legs and, especially, in the very different male hypopygium.

ERIOPTERINI

GONOMYIA (LIPOPHLEPS) ACCHETES sp. nov. Plate 2, fig. 21; Plate 4, fig. 47.

Belongs to the *perpicta* group; size large (wing over 5 millimeters); general coloration polished back, the pronotum, pretergites and mesonotal scutellum light yellow; halteres yellow; antennæ and legs black; wings strongly tinged with brown, stigma vaguely more darkened; vein R_1 elongate, exceeding R_{2+3+4}; male hypopygium with the outer dististyle glabrous, dilated at outer end; inner style terminating in a strong

spine; phallosome with two pairs of strong spines or narrow blades and a strong recurved blackened central spine.

Male.—Length, about 5.5 millimeters; wing, 5.3.

Rostrum brownish black; palpi black. Antennæ black; flagellar segments elongate, with long verticils, as in the subgenus. Head black.

Pronotum light yellow, sides of the scutellum darkened; pretergites light yellow, more extensively so before the wing root. Mesonotum polished black; scutellum broadly light yellow, restrictedly darkened medially at base, parascutella black. Pleura black, the pteropleurite and meron more pruinose. Halteres clear light yellow. Legs with coxæ black; trochanters brown; remainder of legs black. Wings (Plate 2, fig. 21) strongly tinged with brown, the costal region slightly more yellowed; stigmal region very slightly and vaguely darkened; veins light brown. Macrotrichia on veins R_4, R_5, both outer section of M_{1+2}, M_3, M_4 and distal section of Cu_1, lacking on R_{2+3+4} and R_4. Venation: Sc short, Sc_1 ending just before origin of Rs, Sc_2 at its extreme tip; cell R_3 present, vein R_4 elongate, exceeding R_{2+3+4}; m–cu close to fork of M; anterior arculus lacking.

Abdomen brownish black, hypopygium more intensely blackened. Male hypopygium (Plate 4, fig. 47) with the dististyles, *d*, terminal or virtually so; apex of basistyle with a concentration of strong yellow setæ; outer dististyle a strong glabrous arm, its outer end dilated; inner style with outer end with abundant setæ, extended into a long spine. Phallosome, *p*, complex in structure, as shown, including a pair of long black tipped spines, with microscopic setulæ before apex; a pair of slightly shorter narrowly flattened blades that are extended into acute points, the surface with long appressed setæ; a strong central organ, extended into a recurved black spine.

Habitat.—Northeast New Guinea.

Holotype, male, Mount Otto, above Kabebe, altitude 2,100 meters, June 23, 1955 (*Gressitt*).

Distinguished from other members of the *perpicta* group by the coloration of the body and legs and, especially, by the structure of the male hypopygium, particularly the dististyles and phallosome. These allied species include *Gonomyia* (*Lipophleps*) *citribasis* Alexander, *G.* (*L.*) *fuscofemorata* Alexander, *G.* (*L.*) *ischyria* Alexander, *G.* (*L.*) *perpicta* Alexander, and *G.* (*L.*) *tenuipollex* Alexander.

GONOMYIA (LIPOPHLEPS) BICIRCULARIS sp. nov. Plate 2, fig. 22; Plate 4, fig. 48.

Size small (wing of male 3.8 millimeters); mesonotum dark gray, variegated with yellow; pleura with a broad white longitudinal stripe; legs brownish black; wings strongly tinged with brown, vaguely patterned with paler before and beyond cord; stigma pale brown, preceded and followed by pale areas; Sc_1 ending before origin of Rs, basal section of R_5 long; male hypopygium with dististyles terminal, outer style profoundly bifid, inner style terminating in a blackened spine; phallosome very compact and massive, unblackened, including three pairs of structures, consisting of subcircular disklike plates and a pair of reddish brown brushes.

Male.—Length, about 4 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments elongate, with very long verticils, as in the males of this subgenus. Head yellow, clearest behind, the center of the disk darkened.

Pronotum and pretergites light yellow. Mesonotum dark gray, the lateral præscutal borders and posterior margins of scutal lobes yellow, the discal area of midregion of scutum more obscure yellow; scutellum broadly yellow posteriorly, the base darkened; postnotum broadly yellow, the extreme cephalic end of mediotergite and broader posterior border of the remainder darkened. Pleura grayish black ventrally, with a broad white longitudinal stripe, dorsal pleurites light brown; anterior dorsopleural region and the propleura brownish black. Halteres broken. Legs with the fore and hind coxæ yellow, middle pair darkened on basal half, the apex light yellow; trochanters yellow; remainder of legs brownish black. Wings (Plate 2, fig. 22) strongly tinged with brown, prearcular and costal regions light yellow; stigma long-oval, pale brown, preceded and followed by pale areas; cord vaguely seamed with darker; cells before and beyond cord vaguely paler in places to produce a diffuse pattern; veins light brown, light yellow in costal area. Venation: Sc short, Sc_1 ending some distance before origin of Rs, Sc_2 near its tip; branches of Rs strongly divergent, basal section of R_5 relatively long; m-cu shortly before fork of M.

Abdomen dark brown, hypopygium obscure yellow. Male hypopygium (Plate 4, fig. 48) with the dististyles, *d*, terminal, the outer style longest, profoundly divided near base, outer arm gradually narrowed to the obtuse tip, mesal edge near base with a small blackened tooth (this not evident on one style of the

type); inner arm a little shorter, very gradually narrowed into a long blackened spine; inner style short, at apex bent at a strong angle into a blackened spine, inner margin with a series of strong setæ, none definitely more enlarged or fasciculate. Phallosome, *p*, distinctive, appearing as a large central mass (on the slide mount flattened in order to show the individual parts), consisting of three paired elements, including a lower pair of subcircular disks, a central arm that terminates in a compact brush of long yellow setæ, and a pair of strong bent hooks or spines, the two slightly dissimilar in shape; none of the phallosomic elements blackened.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, male, Debei-Itouda, August 14, 1955 (*Gressitt*).

Most similar to regional species such as *Gonomyia* (*Lipophleps*) *acus* Alexander, *G.* (*L.*) *biserpentigera* Alexander, and *G.* (*L.*) *subacus* sp. nov., differing conspicuously from all in the structure of the male hypopygium.

GONOMYIA (LIPOPHLEPS DISPAR sp. nov. Plate 2, fig. 23, Plate 4, fig. 49.

Size medium (wing of male 5 millimeters); mesonotum dark brown, scutellum more testaceous yellow; head gray, anterior vertex relatively narrow; wings tinged with brown, prearcular and costal fields more yellowed; Sc_1 ending just beyond origin of Rs; male hypopygium with the dististyles of the two sides very dissimilar; phallosome entirely pale, without acute spines or points, longest element consisting of two approximated pale rods.

Male.—Length, about 4.5 millimeters; wing, 5.

Rostrum brownish yellow; palpi black. Antennæ relatively long, black, scape and pedicel more obscure yellow on basal parts; flagellar segments elongate-cylindrical, with the usual very long verticils and abundant white pubescence. Head light gray; anterior vertex relatively narrow, subequal to the diameter of the scape.

Pronotum light yellow, pretergites narrowly of the same color. Mesonotum dark brown, the scutellum and midregion of scutum more testaceous yellow; postnotum gray. Pleura and pleurotergite reddish brown, with a broad obscure gray longitudinal stripe on the former. Halteres obscure yellow. Legs with coxæ and trochanters obscure yellow, the fore coxæ more darkened basally; remainder of legs broken. Wings (Plate 2, fig. 23) tinged with brown, the prearcular and costal fields more yellowed; stigmal region vaguely more darkened; veins light

brown. Venation: Sc_1 ending just beyond origin of Rs, Sc_2 before this point; branches of the Rs diverging widely at outer ends, the base of cell R_2 relatively narrow; m-cu close to fork of M.

Abdominal tergites brown, sternites and hypopygium more brightened. Male hypopygium (Plate 4, fig. 49) with the dististyles of the two sides asymmetrical. Basistyle, *b*, with the outer apical lobe stout, apex obtuse, dististyles subterminal. Both dististyles, *d*, with the usual basal lobe, terminating in a single powerful fasciculate bristle, with other more normal setæ, the outermost long, exceeding in length the fasciculate bristle; one style produced into a long straight arm that is gently expanded outwardly, narrowed into a spine, before tip with about four setæ; second style with the comparable spine much smaller, narrowed gradually to the acute apex. Phallosome, *p*, entirely pale, without acute spines or points, including a cylindrical structure comprised of two pale rods, these presumably representing the ædeagus, and a larger fleshy organ.

Habitat.—Northeast New Guinea.

Holotype, male, Mount Otto, above Kabebe, altitude 2,100 meters, June 24, 1955 (*Gressitt*).

The present fly is readily told from all other similar members of the subgenus by the asymmetrical dististyles of the male hypopygium.

GONOMYIA (LIPOPHLEPS) MELANOSTYLA sp. nov. Plate 2, fig. 25; Plate 4, fig. 50.

Belongs to the *abbreviata* group; mesonotal præscutum and scutal lobes black, remainder of notum and the pleura chiefly yellow; legs black; wings weakly tinged with brown, Sc short, cell R_3 very small; male hypopygium with the tergite produced into two very long straight spines; dististyles terminal, blackened, the outer style with a comblike row of teeth, inner style terminating in two blackened spines; phallosome with two pairs of spinelike rods or points.

Male.—Length, about 4.3 to 4.5 millimeters; wing, 4 to 4.2.

Female.—Length, about 5 millimeters; wing, 4.8.

Rostrum light yellow; palpi black. Antennæ with scape yellow, pedicel enlarged, black, flagellum brownish black; flagellar segments elongate, the males with the usual very long verticils. Head dark gray.

Pronotum and pretergites light yellow. Mesonotal præscutum and scutal lobes polished black, with a sparse bloom, most

evident laterally, pseudosutural foveæ black; scutellum, the broad central area of scutum and the posterior margins of the scutal lobes yellow; mediotergite light yellow on anterior half, dark brown behind; pleurotergite yellow. Pleura light yellow, the propleura and especially the mesepisternum variegated with reddish brown. Halteres dusky, the base of stem light yellow, apex of knob obscure yellow. Legs with fore coxæ reddish brown, remaining coxæ light yellow; trochanters brownish yellow; remainder of legs black. Wings (Plate 2, fig. 25) weakly tinged with brown, the prearcular and costal fileds more yellowed; stigma not or scarcely darkened; veins light brown. Macrotrichia on vein R_5, all outer medial branches, Cu, and on outer ends of veins M, Cu and anals, lacking on Rs and its anterior branch. Venation: Sc short, Sc_1 ending a distance before origin of Rs only a little less than the length of the latter; Rs arcuated at origin, in cases strongly so; cell R_3 small to very small; cell R_5 narrowed at margin; m-cu at fork of M.

Abdomen with tergites dark brown, the outer apical angles restrictedly yellowed; basal sternites light yellow, the bases of the outer segments darkened; subterminal segment yellowed; hypopygium chiefly blackened, especially the styli. Male hypopygium (Plate 4, fig. 50) with the tergite, *t*, produced into two long straight divergent rods, their outer ends with microscopic setulæ. Dististyles, *d*, terminal, there being no apical lobe on basistyle; outer style a blackened rod, dilated at base, slightly constricted at midlength, the entire inner face with a comblike row of teeth, smaller and less evident at either end of the row; inner style small, blackened outwardly, terminating in two unequal spines, lower surface with several strong setæ, the terminal pair longer and subfasciculate. Phallosome, *p*, including two pairs of rods, the outer very long, the very slender blackened tips decussate at midlength; lateral rods more basal in position, narrowed to blackened spinelike tips; ædeagus pale, tip strongly decurved.

Habitat.—Northeast New Guinea.

Holotype, male, Nondugl, Ahl Valley, July 8, 1955 (*Gressitt*). Allotopotype, female, pinned with type. Paratopotype, male.

The present fly is readily told from all other regional members of the subgenus that have cell R_3 present by the very small size of this cell and the short Sc. The male hypopygium, especially the tergite, dististyles and phallosome, are quite distinctive.

GONOMYIA (LIPOPHLEPS) PLEUROSTRIATA Alexander.

Plate 2, fig. 24; Plate 4, fig. 51.

Gonomyia (Lipophleps) nigridorsata pleurostriata ALEXANDER, Proc. Linn. Soc. New South Wales 61 (1936) 330.

Hitherto known only from the female sex, collected at Edie Creek, Northeast New Guinea, altitude 6,550 feet, in February 1935 by Frank H. Taylor.

Netherlands New Guinea: Enagotadi, Wisselmeren area, altitude 2,000 meters, July 31, 1955 (*Gressitt*).

The discovery of the male shows that this is a distinct species from *nigridorsata* Alexander, distinguished not only by the coloration of the thorax, as described, but especially by the structure of the male hypopygium.

The wing venation (Plate 2, fig. 24) is very similar to that of *nigridorsata*. Male hypopygium (Plate 4, fig. 51) distinctive in the great elongation of the outer lobe of the basistyle, *b*, which is nearly twice as long as the base, pale, provided with unusually long setæ on inner face. Dististyle, *d*, including a large pale flattened outer blade and a smaller basal structure that narrows strongly at apex and bears the usual fasciculate seta; on outer margin before the narrowed part with a small tubercle that bears a single very long bristle; other strong but more normal setæ on outer half of style. Phallosome, *p*, elongate, including a pale central mass, truncated at tip, subtended by two strong apophyses or spines, one longer and more curved than the other.

GONOMYIA (LIPOPHLEPS) RECLINATA sp. nov. Plate 2, fig. 26; Plate 4, fig. 52.

General coloration of thoracic notum brownish gray, scutellum silvery white, pleura with a broad silvery longitudinal stripe; femora infuscated above, obscure yellow on lower surface, tips darkened; wings weakly suffused, stigma faintly indicated; basal section of vein R_5 very long, transverse; posterior borders of abdominal segments narrowly silvery; male hypopygium with the inner dististyle terminating in an acute spine, with an appressed reclinate spine on outer margin at near two-thirds the length, the fasciculate setæ subterminal.

Male.—Length, about 4.5 millimeters; wing, 4.5.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ with scape black beneath, light yellow above; pedicel and flagellum black; flagellar segments with very long verticils in the male, as in the subgenus.

Head above yellow, the center of the posterior vertex extensively brownish black, pruinose.

Pronotum whitened, infuscated on sides; pretergites narrowly whitened. Mesonotal præscutum brownish gray, pseudosutural foveæ black; scutal lobes dark brown, pruinose, the central area extensively more obscure yellow except behind, posterior lateral angles of lobes whitened; scutellum with base of disk blackened, the remainder broadly silvery white; mediotergite pruinose, obscure yellow on anterolateral parts, pleurotergite silvery gray above, narrowly blackened ventrally. Pleura with sternopleurite black, above which is a broad silvery longitudinal stripe, narrowly bordered above by a blackish line, the dorsal sclerites, including the dorsopleural membrane, light brown. Halteres with stem yellow basally, darkened outwardly, knob black, the outer end more brightened. Legs with fore coxæ silvery, remaining coxæ brownish black; trochanters brownish yellow; femora infuscated above, obscure yellow on longer surface, the tips broadly more blackened; tibiæ yellow, the extreme base and narrow tip blackened; tarsi black. Wings (Plate 2, fig. 26) weakly suffused, prearcular and costal fields slightly more yellowed; stigma oval, very pale brown; veins light brown, the cord darker. Macrotrichia on all veins beyond cord. Venation: Sc_1 ending just beyond origin of Rs, Sc_2 just before this point; basal section of R_5 unusually long, subequal to m, transverse in position; inner end of cell 1st M_2 strongly narrowed; m cu about one-third its length before the fork of M.

Abdominal segments black, sparsely pruinose, the posterior borders narrowly silvery; hypopygium chiefly brown. Male hypopygium (Plate 4, fig. 52) with the basistyle simple, some of the outer setæ very long. Two dististyles, *d*, the outer an elongate glabrous rod, at base with an attached oval lobe that is densely covered with pale curved setulæ; inner style a sinuous rod, narrowed into an acute spine, on outer face at near two-thirds the length with an appressed acute spine; the usual two fasciculate setæ lie on the lower margin of the style opposite the lateral spine; remainder of surface with several conspicuous erect bristles. Phallosome, *p*, includes the central ædeagus which terminates in a reflexed blackened cylinder; gonapophyses appearing as slender divergent horns that are extended into long black spines, before the latter with abundant setulæ; outer margin of apophysis at base with a further acute straight spine.

Habitat.—Northeast New Guinea.

Holotype, male, Goroka, foot of Mount Otto, altitude 2,000 meters, June 25, 1955 (*Gressitt*). Allotopotype, female.

The most similar regional species include *Gonomyia* (*Lipophleps*) *acus* Alexander, *G.* (*L.*) *basicuspis* Alexander and *G.* (*L.*) *subacus* sp. nov., all differing evidently in the structure of the male hypopygium, particularly the dististyles and phallosome.

GONOMYIA (LIPOPHLEPS) SUBACUS sp. nov. Plate 2, fig. 27; Plate 4, fig. 53.

General coloration of thoracic dorsum black, gray pruinose, scutellum whitened; rostrum and antennæ black throughout; legs dark brown; wings tinged with brown, basal section of vein R_5 long, transverse, Sc_1 ending opposite origin of Rs; male hypopygium with the dististyles terminal, the outer a long slender spine, its base not dilated; inner style at base with a low setiferous cushion.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments elongate, with very long verticils in the male. Head dark brown, sparsely pruinose.

Pronotum brownish black, narrowly whitened above; pretergites very restrictedly whitened. Mesonotal præscutum and scutum black, the former brownish gray pruinose, the latter clearer gray; pseudosutural foveæ black; scutellum whitened, dark brown medially at base; postnotum dark brown, sparsely pruinose. Pleura black, sparsely pruinose, with a grayish longitudinal stripe extending from behind the fore coxæ almost to the abdomen. Halteres with stem dirty white, knob darkened basally, apex obscure yellow. Legs with coxæ dark brown to brownish black; remainder of legs uniformly dark brown. Wings (Plate 2, fig. 27) tinged with brown, base and costal border whitened; stigma vaguely indicated, pale brown; veins brown. Venation: Sc_1 ending opposite origin of Rs, Sc_2 slightly removed; basal section of R_5 long, transverse; branches of Rs divergent; m–cu shortly before the fork of M.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 4, fig. 53) with the dististyles, *d*, terminal, the outer style a long spine, very gradually narrowed to a needle-like point, the base not dilated as in *acus;* inner style bearing a low setiferous cushion on outer surface near base. Phallosome, *p*, including a massive decurved darkened central structure and divergent apophyses, each of the latter terminating in a long

spines, with smaller closely appressed spinules along the outer margin; ædeagus small, the tip recurved.

Habitat.—Northeast New Guinea.

Holotype, male, Nondugl, Ahl Valley, July 8, 1955 (*Gressitt*).

Although generally similar to *Gonomyia* (*Lipophleps*) *acus* Alexander, the present fly is quite distinct in the details of structure of the male hypopygium, particularly the dististyles and phallosome.

GONOMYIA (LIPOPHLEPS) SUBÆGINA sp. nov. Plate 2, fig. 23; Plate 4, fig. 54.

Allied to *ægina;* general coloration of mesonotum dark brown, scutellum yellow; rostrum clear light yellow; antennæ of male black throughout, flagellar segments elongate, with long outspreading black setæ; pleura dark brown, with a conspicuous yellow longitudinal stripe; legs dark brown; wings tinged with brown; Sc long, Sc_1 ending at near two-fifths the length of the long Rs; male hypopygium with the outer apical lobe relatively short and slender; outer dististyle short, nearly straight, the blackened apical spine about one-fourth as long as the base; inner style terminating in a single fasciculate bristle; phallosome a depressed-flattened central plate, the apex relatively slender.

Male.—Length, about 4 millimeters; wing, 4.2.

Female.—Length, about 4.5 millimeters; wing, 4.5.

Rostrum clear light yellow; palpi black. Antennæ of male black throughout; flagellar segments elongate, with abundant long erect black setæ that exceed the segments in length and are only a little shorter than the longest verticils. Head above chiefly yellow on the central part, more pruinose adjoining the eye.

Pronotum and pretergites light yellow. Mesonotal præscutum and scutal lobes dark brown, the median region of scutum and the scutellum light yellow, the two latter areas separated by a narrow darkening at posterior end of scutum; postnotum black, mediotergite grayish on sides. Pleura dark brown, with a broad conspicuous pale yellow longitudinal stripe extending from the propleura to the base of abdomen, passing beneath the halteres, the dorsopleural region somewhat lighter brown. Halteres darkened, the base of stem and apex of knob restrictedly obscure yellow. Legs with coxæ light brown basally, paling to yellow outwardly; trochanters dusky; remainder of legs uniformly dark brown. Wings (Plate 2, fig. 28) tinged with brown, prearcular and costal regions slightly more yellowed;

stigmal region vaguely darkened; veins light brown. Venation: Sc long, Sc_1 ending at near two-fifths the long Rs, Sc_2 slightly removed; basal section of R_5 relatively short, the branches of Rs thus not widely separated at origin; m–cu shortly before fork of M.

Abdomen dark brown, hypopygium more brownish yellow. Male hypopygium (Plate 4, fig. 54) generally as in *ægina*, differing in all details. Basistyle, *b*, with outer apical lobe relatively short and slender. Outer dististyle, *d*, short, nearly straight, the black apical spine about one-fourth as long as the enlarged base; inner style relatively slender, terminating in a single powerful fasciculate seta, with other setæ on style, one outer one of unusual length, more than one-half the length of the style. In *ægina* all parts of the dististyles more elongate. Phallosome, *p*, a depressed-flattened central plate, its apex relatively slender; two unequal spines or apophyses, the longest sinuous, pale at tip.

Habitat.—Northeast New Guinea.

Holotype, male, Nondugl, Ahl Valley, July 8, 1955 (*Gressitt*). Allotopotype, female.

Although the present fly is evidently allied to *Gonomyia* (*Lipophleps*) *ægina* Alexander in the venation and general conformation of the male hypopygium it differs in all details of structure of the latter.

STYRINGOMYIA ELANOPINAX FESTIVA subsp. nov. Plate 5, fig. 55.

Very similar to typical *melanopinax* Alexander, differing chiefly in the structure of the male hypopygium, particularly the dististyles.

Male.—Length, about 6.8 to 7 millimeters; wing, 4 to 4.5.

Female.—Length, about 5 millimeters; wing, 4.

Rostrum obscure yellow; palpi darker. Antennæ with scape black beneath, obscure yellow on dorsal half; pedicel black, flagellum yellowish white. Head yellow, the occiput with two brownish spots.

Pronotum yellow, sides of scutum brownish black. Mesonotal præscutum black on anterior half, pruinose on the humeri, obscure yellow or brownish yellow behind, the usual interspaces indicated by narrow lines; scutum yellow, each lobe with a U-shaped dark brown border, interrupted in front; scutellum black, with a small central yellow spot; postnotum black, sparsely pruinose; vestiture black, erect. Pleura and anterior end of

pleurotergite reddish yellow. Halteres pale yellow. Legs with coxæ and trochanters yellow; femora yellow, conspicuously patterned with brownish black, including incomplete rings at near midlength and before tip, extreme apex darkened; middle femora with strong black setæ near tip, those of the posterior femora longer but paler; tibiæ yellow, with a narrow incomplete ring before midlength, the tips broadly black; tarsi yellow, the tips of the segments narrowly darkened, terminal segment black. Wings yellow with a restricted brown pattern, including areas over r–m, outer end of cell 1st M_2, posterior end of m–cu, and at outer end of vein 2nd A; very faint marginal markings at ends of veins, not involving the membrane; remaining veins yellow. Coastal fringe of male relatively long and delicate. Venation: Anterior branch of Rs oblique; cell 1st M_2 relatively short, widened outwardly; cell 2nd M_2 sessile; m–cu at near midlength of cell 1st M_2; vein 2nd A weakly angulated and slightly spurred before tip.

Abdomen yellow; tergites restrictedly patterned with brown, including a pair of transverse marginal lines on each segment, more extensive on sixth segment; segment seven with two suboval central areas; outer segments yellow. Male hypopygium (Plate 5, fig. 55) with the tergite, *t*, not trilobed, as in *papuana*, appearing as an oval cushion, narrowed outwardly, the outer vestiture long and conspicuous; body of tergite behind the cushion with a pair of elongate setæ; sternite, *s*, broad, the relatively small outer setæ separated from one another by a distance slightly less than their own length. Basistyle, *b*, with a single modified spinelike seta from a long basal tubercle. Dististyle, *d*, about as figured, the lower blackened blade bifid at tip. Phallosome including a long slender blackened rod.

Habitat.—Northeast New Guinea.

Holotype, male, Busu, Lae area, September 15, 1955 (*Gressitt*). Allotopotype, female, pinned with type. Paratopotypes, males and females, with the types.

STYRINGOMYIA PLATYSTYLA sp. nov. Plate 2, fig. 29; Plate 5, fig. 56.

General coloration yellow; mesonotum with scattered small brown spots, including six areas each on the præscutum and scutum; femora and tibiæ yellow, restrictedly patterned with brown; wings yellow, the veins extensively darkened; abdomen yellow, intermediate tergites with tips and a central darkening brown; male hypopygium with the sternite broad; basistyle with a single modified outer bristle; dististyle very broad, in-

cluding its outer arm, provided with very abundant brownish black spinelike setæ.

Male.—Length, about 7.5 millimeters; wing, 5.5.

Female.—Length, about 5.5 millimeters; wing, 5.

Rostrum and palpi yellow. Antennæ light yellow. Head yellow, setæ yellow, proclinate.

Pronotum obscure yellow, setæ black, erect. Mesonotum reddish yellow, clearer yellow laterally, with small subequal brownish black spots, including six on disk of præscutum, three on margins of each scutal lobe, and two on margin of scutellum; mediotergite with more extensive brown areas, narrowly separated on the midline; disk of scutellum with a pair of long divergent black bristles; pleurotergite reddish yellow, its posterior end darkened. Pleura reddish yellow. Halteres yellow. Legs with all coxæ and trochanters light yellow; femora yellow, with a small darkened spot on dorsal surface at near two-thirds the length; tibiæ yellow, with a vague pale brown ring at near one-third the length; tarsi yellow, last segment abruptly blackened; legs with abundant long pale setæ; femora with strong black erect bristles near tip. Wings (Plate 2, fig. 29) yellow, the base and costal region more saturated; a relatively extensive brown pattern that is virtually restricted to the veins, not involving the adjoining membrane; the chief darkened areas include the anterior branch of Rs, basal section of R_5 r–m, m–cu, outer end of cell 1st M_2, ends of all outer veins, most extensive on 2nd A where about the outer two-thirds is included; remaining veins yellow. Venation: Anterior branch of Rs oblique; cell 1st M_2 elongate, exceeding any of the veins beyond it; m–cu shortly before midlength of cell 1st M_2; vein 2nd A bent at a right angle into the margin.

Abdomen yellow, intermediate tergites conspicuously patterned with dark brown, including narrow posterior borders and a smaller isolated spot at near midlength of the segment; hypopygium pale. Male hypopygium (Plate 5, fig. 56) with the tergite, *t*, narrowed outwardly into a broad lobe, its apex further narrowed, on sides before the narrowed part with strong setæ, those elsewhere on lobe somewhat smaller. Sternite, *s*, very broad, including a subquadrate central cushion and glabrous subtending blades, the latter with obtuse tips. Basistyle, *b*, with a single strong modified bristle, subapical in position, from a small basal lobe, all other setæ smaller. Dististyle, *d*, very broad, including the outer arm which terminates in the

usual elongate subterminal bristle; spinelike setæ very numerous on both arms, arranged generally as shown in the figure. Phallosome, *p*, consisting of paired blackened pendant lobes.

Habitat.—Netherlands New Guinea (Wisselmeren area).

Holotype, male, Okaitadi, altitude 1,760 meters, August 7, 1955 (*Gressitt*). Allotopotype, female.

The most similar regional species is *Styringomyia spinicaudata* Alexander which has somewhat similar spinelike setæ on the dististyle of the hypopygium but with these quite different in distribution. The present fly is entirely distinct in the structure of the tergite, sternite and dististyle.

STYRINGOMYIA SCALARIS sp. nov. Plate 2, fig. 30; Plate 5, fig. 57.

Size large (wing 6 millimeters or more); general coloration yellow, restrictedly patterned with brown; abdomen conspicuously crossbanded with yellow and brown; legs yellow, femora and tibiæ unpatterned; wings yellow, restrictedly patterned with brown; vein 2nd A long, curved gently to the margin; male hypopygium with the sternite very broad, its apex nearly truncate, without modified setæ; basistyle with apical lobe stout, at tip with several strong setæ, the innermost slightly larger than the others; dististyle very simple.

Male.—Length, about 7 millimeters; wing, 6.5.

Female.—Length, about 6.5 millimeters; wing, 6.

Rostrum yellow; palpi yellowish brown. Antennæ with scape and pedicel brownish yellow, flagellum somewhat paler yellow. Head yellow; vertical setæ relatively weak and inconspicuous.

Pronotum yellow, narrowly margined laterally with darker. Mesonotal præscutum and scutum reddish yellow, surface faintly pollinose; præscutal pattern barely indicated; a circular black spot on suture just mesad of wing base; scutellum yellow, weakly patterned with brown on either side; a pair of erect discal scutellar bristles; parascutella more or less darkened; mediotergite reddish brown, patterned on either side with dark brown. Pleura yellow. Halteres with stem yellow, knob weakly darkened. Legs with coxæ and trochanters yellow; remainder of legs light yellow, extreme tip of femur and last tarsal segment blackened. Wings (Plate 2, fig. 30) strongly suffused with yellow; a restricted dark pattern, including a cloud on anterior cord, involving r–m and basal section of R_5; m–cu and outer end of cell 1st M_2 darkened; veins light yellow, darkened in the patterned areas. Venation: Cell 2nd M_2 barely to more broadly sessile; vein 2nd A long, curved gently to margin.

Abdominal tergites conspicuously crossbanded, central part and extreme base yellowed, the apex and subbasal part of each broadly dark brown, producing a ladderlike appearance; sternites yellow or with the banded pattern less evident; genitalia of both sexes yellow. Male hypopygium (Plate 5, fig. 57) with the tergite, *t*, broad, narrowed outwardly, terminating in a small truncated lobe. Sternite, *s*, unusually broad, apex nearly truncate, the margin with abundant blackened setulæ but without modified setæ, as common in the genus. Basistyle, *b*, with apical lobe stout, with several setæ of approximately equal length, the innermost a little stouter, at base of lobe with a concentration of strong black setæ, with a further basal group on mesal face. Dististyle, *d*, very simple, without an outer arm, as common in the genus; along inner margin with a row of blackened peglike spines, with subobtuse tips; apex of style farther produced into a circular dusky blade, in center of which is a single powerful bristle. Phallosome, *p*, about as illustrated, including a strongly curved central structure, with a pair of stout decurved blackened points; other blackened parts, as shown.

Habitat.—Northeast New Guinea.

Holotype, male, Mount Wilhelm, altitude 2,700 meters, July 4, 1955 (*Gressitt*). Allotopotype, female, pinned with type. Paratopotypes, 1 male, 1 female; paratype, 1 male, Mount Otto, altitude 2,100 to 2,600 meters, June 22, 1955 (*Gressitt*).

This primitive member of the genus has no close regional ally, being most similar to the Australian *Styringomyia bipunctata* Edwards. It is readily told from other species in New Guinea by the unpatterned femora and cross-banded abdomen. The male hypopygium is particularly characteristic, especially in the very broad unmodified sternite and the small simple dististyle.

TOXORHINA (CERATOCHEILUS) GRESSITTI sp. nov. Plate 2, fig. 31; Plate 5, fig. 58.

General coloration of thorax light fulvous, pleura with a broad brownish black longitudinal stripe; rostrum longer than the wing; halteres pale yellow; legs brown; wings pale yellow, with a heavy reticulated brown pattern; anterior branch of Rs nearly transverse, cell M_2 open by atrophy of m, vein M_3 strongly arcuated; male hypopygium with two dististyles, both with a small lateral tooth on lower margin; arms of ædeagus relatively long.

Male.—Length, excluding rostrum, about 6.5 millimeters; wing, 5.8; rostrum, about 8.

Rostrum very long, about one-fourth longer than the wing, brownish black throughout. Antennæ black, scape, pedicel and fusion segment of flagellum more intensely so. Head gray; anterior vertex narrow, about one-half the diameter of scape.

Cervical region and pronotum black. Mesonotal præscutum light fulvous, the margins paling to light yellow; posterior sclerites of notum chiefly fulvous, central region of scutum and postnotum more yellowed. Pleura pale yellow, with a broad brownish black longitudinal stripe, extending from the sides of the pronotum over the dorsal pleurites to the base of the abdomen passing just beneath the halteres. Halteres pale yellow. Legs with all coxæ and trochanters pale yellow; remainder of legs brown. Wings (Plate 2, fig. 31) pale yellow, the prearcular and costal fields more saturated; an extensive variegated or tessellated light brown pattern that is subequal in amount to the ground, including sparse marks in all cells, more extensive in cell R, origin of Rs and over the anterior branch of Rs; posterior marginal areas extensive and more or less confluent; cell M with a series of about five small spots; veins pale, darker in the patterned areas. Macrotrichia on veins of outer half of wing, including Rs, R_5 and distal section of M_{1+2}; only one or two on M_3; none on anterior branch of Rs or the remainder of M. Venation: Sc_1 ending just beyond origin of Rs; anterior branch of Rs nearly transverse, straight, basal section of R_5 about one-half as long; cell M_2 open by atrophy of m; M_3 strongly arcuated, narrowing cell M_2 at near two-thirds its length; m–cu shortly before fork of M.

Abdomen yellow, the eighth and ninth segments extensively infuscated but more or less patterned with yellow. Male hypopygium (Plate 5, fig. 58) with the central region of tergite produced, the margin strongly convex; setæ strong. Basistyle, *b*, with abundant long setæ on mesal face, some of the more basal ones very long. Dististyles, *d*, two, outer style a small sclerotized structure, broad at base, narrowed into a straight spine, with a small decurved spur on lower margin at base of spine; inner style much larger, flattened, with a strong lower marginal tooth, apex obtuse. Phallosome with gonapophyses narrowed strongly into subacute points. Arms of ædeagus, *a*, relatively long, divergent.

Habitat.—Netherlands New Guinea (Wisselmeren area).

Holotype, male, Itouda, altitude 1,500 meters, August 14, 1955 (*Gressitt*).

This very distinct fly is named in honor of the collector of this outstanding series of crane-flies, Dr. J. Linsley Gressitt. It is quite distinct from the other regional members of the subgenus having conspicuously variegated wings in the small size, arrangement of the wing pattern, and in the structure of the male hypopygium. Such regional species include *Toxorhina (Ceratocheilus) imperatrix* Alexander, *T. (C.) nympha* Alexander and *T. (C.) toxopæna* Alexander.

TOXORHINA (CERATOCHEILUS) HOOGSTRAALI Alexander. Plate 2, fig. 32.

Toxorhina (Ceratocheilus) hoogstraali ALEXANDER, Ann. Mag. Nat. Hist. (11) 14 (1947) 279–280.

The type was from Hollandia, Netherlands New Guinea, collected by Dr. Harry Hoogstraal.

Northeast New Guinea: Korip, July 12, 1955 (*Gressitt*).

Female.—Length, excluding rostrum, about 9 millimeters; wing, 6.3; rostrum, about 10.

The present fly agrees well with the type except in the very long rostrum which, with the accession of more material, may be found to indicate a new race.

Wings (Plate 2, fig. 32) tinged with brown, slightly clouded with darker brown especially in the outer radial field, including seams over Rs and its anterior branch, and the broad outer margin of cell R_3. Macrotrichia on veins Rs, R_2, M_{1+2}, M_3, with single or fewer setæ on anterior branch of Rs, r-m and M_4. Venation: m-cu about its own length beyond the fork of M or at near one-third the length of M_{3+4}.

TOXORHINA (CERATOCHEILUS) INFUSCULA sp. nov. Plate 2, fig. 33; Plate 5, fig. 59

Mesonotum buffy brown, pleura with a broad black dorsal stripe; wings infuscated, especially over the veins; veins R_{1+4} and R_2 widely separated at margin, Sc short; male hypopygium with the outer dististyle broad basally, the distal third suddenly narrowed into a small cultriform beak; gonapophyses dusky, long-triangular in outline, tips narrowly obtuse; arms of ædeagus relatively long and slender, tips obliquely truncated.

Male.—Length, excluding rostrum, about 6.5 to 6.8 millimeters; wing, 5 to 5.4; rostrum, about 8.

Rostrum black, long and slender, exceeding in length the body or wing. Antennæ black (outer end of flagellum broken). Head dark gray; anterior vertex narrow, about equal in width to from two to two and one-half rows of ommatidia.

Cervical region and pronotum black. Mesonotum almost uniformly light brown to buffy brown, unpatterned. Pleura

with more than the dorsal half occupied by a broad black longitudinal stripe that reaches the abdomen, including also the dorsopleural region; ventral pleura abruptly light yellow. Halteres with stem yellow, knob weakly darkened. Legs with coxæ and trochanters pale yellow; remainder of legs dark brown, appearing even darker from the abundant vestiture; outer tarsal segments a little paler. Wings (Plate 2, fig. 33) with the ground infuscated, more heavily so over the cord, anterior branch of Rs and along vein Cu; centers of cells, especially of the disk, slightly brighter. Macrotrichia on Rs, its posterior branch, M_{1+2} and M_3, lacking on anterior branch of Rs, M_{3+4} and M_4. Venation: Sc relatively short, Sc_2 ending just beyond origin of Rs; anterior branch of the latter subtransverse, straight; distance on margin between R_{1+2} and R_3 extensive, about two-thirds the length of the later; cell M_3 small; M_{3+4} about three times M_4; m-cu about one-third its length before fork of M, subequal to distal section of Cu_1.

Abdomen black, including the hypopygium. Male hypopygium (Plate 5, fig. 59) with posterior border of tergite narrowed outwardly, the apex truncated. Basistyle, *b*, with normal darkened setæ on outer face, the mesal surface with longer yellow strongly twisted bristles to present a roughened appearance; outer mesal angle of style produced into a low blackened lobe. Outer dististyle, *d*, broad on basal two-thirds, the apex suddenly narrowed into a small cultriform beak; inner style large, the margin with small setuliferous tubercle. Gonapophysis darkened, long-triangular in outline, tip narrowly obtuse. Ædeagus, *a*, with the arms relatively long and slender, the tips obliquely truncate.

Habitat.—Northeast New Guinea.

Holotype, male, Karap, July 20, 1955 (*Gressitt*). Paratype, male, Korip, July 12, 1955 (*Gressitt*).

The most similar described regional species is *Toxorhina* (*Ceratocheilus*) *kokodæ* Alexander which differs in coloration, venation, and especially in the structure of the male hypopygium, particularly of the outer dististyle.

TOXORHINA (CERATOCHEILUS) TRICHOPYGA sp. nov.

Plate 2, fig. 34; Plate 5, fig. 60.

Size medium (wing of male about 5.5 millimeters); rostrum shorter than the wing; mesonotum chiefly light gray, præscutum with three confluent dark brown stripes; pleura dark brown with a gray longitudinal stripe; halteres yellow; legs light

brown; wings weakly tinged with brown, unpatterned; anterior branch of Rs oblique, gently sinuous; male hypopygium with the tergite terminating in a pair of small blackened lobes; outer face of basistyle with unusually long coarse bristles; inner dististyle large, of distinctive conformation; arms of ædeagus long.

Male.—Length, excluding rostrum, about 5.5 millimeters; wing, 5.4; rostrum, about 4.5.

Rostrum elongate but shorter than the body or wing, brownish black. Antennæ broken beyond the base of scape. Head gray, the narrow anterior vertex with a central blackened vitta.

Cervical region and pronotum brownish black. Mesonotal præscutum light gray, the anterior margin more buffy, disk with three confluent dark brown stripes, scutal lobes similarly darkened; remainder of notum light gray. Pleura dark brown, sparsely pruinose, with a broad gray stripe crossing the dorsal sternopleurite, extending backward to the base of abdomen, involving the ventral pteropleurite and metapleura. Halteres yellow. Legs with fore and middle coxæ more or less darkened basally, the posterior pair and the trochanters obscure yellow; remainder of legs light brown (terminal tarsal segments broken). Wings (Plate 2, fig. 34) very weakly tinged with brown, cell R_2 clearer; veins light brown. Strong macrotricha on Rs, both sections of R_5 M_{1+2} and M_3 more numerous and crowded outwardly. Venation: Sc_1 ending nearly opposite one-third the length of Rs, anterior branch of the latter oblique, gently sinuous; vein R_5 terminating close to wing tip; cell M_2 open; m–cu shortly before fork of M.

Abdominal tergites bicolored, the posterior borders of the individual segments brown, the broad bases obscure yellow, on the outer segments becoming more uniformly infuscated; ninth segment, especially the tergite, pale. Male hypopygium (Plate 5, fig. 60) with the posterior border of tergite, *t*, subtruncate, with a pair of blackened lobes that are separated by a narrow V-shaped notch; immediately cephalad of these on disk of tergite with a compact group of about twenty long setæ. Basistyle, *b*, short and compact, the outer face of distal half with several unusually long and powerful bristles, these longer than the dististyle, the more basal ones smaller. Two dististyles, *d*, the outer a sinuous spine from an enlarged base; inner style distinctive, as illustrated, including two flattened blades, the longest dilated on outer half, the apex truncated; lower blade

with delicate apical setæ, the outer margin with a small lobule. Ædeagus, *a*, with the arms long and slender.

Habitat.—Netherlands New Guinea (Wisselmeren Area).

Holotype, male Enagotadi, altitude 1,875 meters, July 31, 1955 (*Gressitt*).

Among the described regional members of the subgenus having unpatterned wings and with the anterior branch of Rs oblique, the present fly is closest to *Toxorhina* (*Geratocheilus*) *fumipennis* Alexander, differing in details of coloration, venation and, especially, the structure of the male hypopygium.

TOXORHINA (TOXORHINA) PROTRUSA sp. nov. Plate 2, fig. 36; Plate 5, fig. 61.

General coloration gray, the præscutum with three conspicuous dark brown stripes; rostrum shorter than wing or remainder of body; knobs of halteres dark brown; legs black, femoral bases pale; wings subhyaline, yellowed at extreme base; Sc short, vein R_5 unusually arched and deflected strongly caudad, ending beyond the wing tip, m–cu before fork of M; male hypopygium with the tergal plate blackened, posterior margin with two low lobes; mesal face of basistyle at apex produced into a lobe; inner dististyle with lateral lobe stout; arms of ædeagus stout, very short, darkened.

Male.—Length, excluding rostrum, about 6 millimeters; wing, 6.8; rostrum, about 5.

Rostrum black, shorter than wing or remainder of body. Antennæ black throughout. Head clear light gray, without cornicular developments; anterior vertex relatively broad, a little less than the diameter of scape or subequal to four rows of ommatidia.

Cervical region and pronotum brown, pruinose. Mesonotal præscutum dull gray with three conspicuous dark brown stripes, the broad median one not reaching the suture behind; posterior sclerites of notum clear gray, the scutal lobes conspicuously dark brown. Pleura, including the dorsopleural region, dark gray. Halteres with stem pale, knob dark brown. Legs with coxæ darkened, pruinose; trochanters chiefly pale; remainder of legs black, the femoral bases pale. Wings (Plate 2, fig. 36) subhyaline, the base, including the veins, yellowed, remaining veins dark brown. Macrotrichia on Rs, R_5, M_{1+2} and M_3. Venation: Sc short, Sc_1 long, ending immediately before origin of Rs; vein R_5 unusually arched beyond origin, deflected strongly caudad, ending beyond the wing tip, cell R_2 thus very extensive;

M_{3+4} and M_4 subequal; m–cu shortly before fork of M, about two-thirds the distal section of Cu_1.

Abdomen brownish black, hypopygium slightly paler. Male hypopygium (Plate 5, fig. 61) with the tergal plate small, blackened, the posterior margin produced into two rounded lobes that are separated by a very shallow emargination. Basistyle, *b*, with strong smooth setæ on mesal face, arranged more or less in longitudinal rows; apex of mesal face with a strong lobe that narrows outwardly into a point. Outer dististyle, *d*, with proximal half dilated, the sinuous outer part slender, its tip acute; inner style elongate, the lobe on outer margin stout. Phallosome with gonapophysis small, pale, subcultrate, tip obtuse; ædeagus, *a*, darkened, the arms stout and very short, lying parallel to one another.

Habitat.—Northeast New Guinea.

Holotype, male, Nondugl, Ahl Valley, July 8, 1955 (*Gressitt*).

Generally similar to species such as *Toxorhina* (*Toxorhina*) *trilineata* Alexander, differing especially in the venation of the outer radial field of the wing. The male of *trilineata* is not known to me.

TOXORHINA (TOXORHINA) PULVINARIA Alexander. Plate 2, fig. 35; Plate 5, fig. 62.

Toxorhina (*Toxorhina*) *pulvinaria* ALEXANDER, Ann. Mag. Nat. Hist. (12) 3 (1950) 958–959.

The types were from Hollandia, Netherlands New Guinea, taken in April by Hoogstraal and from Kokoda, Papua, captured in July and August by Miss Cheesman.

Northeast New Guinea: Korip, July 12, 1955 (*Gressitt*).

The wing venation is shown (Plate 2, fig. 35). Male hypopygium (Plate 5, fig. 62) with the mesal face of basistyle, *b*, near outer end with a concentration of setæ that are microscopically branched. Outer dististyle, *d*, with the apical point long and nearly straight; lateral tooth of inner dististyle slightly recurved. Gonapophysis appearing as a pale subcultrate blade. Arms of ædeagus, *a*, short, parallel to one another.

ILLUSTRATIONS

[Legend: *a*, aedeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *p*, phallosome; *t*, tergite.]

Plate 1

Fig. 1. *Stibadocera luteipennis* sp.nov.; venation.
2. *Limonia* (*Limonia*) *perissoptera* sp.nov; venation.
3. *Limonia* (*Libnotes*) *alterninacula* sp.nov.; venation.
4. *Limonia* (*Libnotes*) *grammonaura* sp.nov.; venation.
5. *Limonia* (*Libnotes*) *philemon* sp.nov.; venation.
6. *Limonia* (*Libnotes*) *rufula* sp.nov.; venation.
7. *Limonia* (*Libnotes*) *viridicolor* sp.nov.; venation.
8. *Limonia* (*Dapanoptera*) *gressittiana* sp.nov.; venation.
9. *Helius* (*Helius*) *gorokanus* sp.nov.; venation.
10. *Helius* (*Rhampholimnobia*) *bigeminulus* sp.nov.; venation.
11. *Helius* (*Rhampholimnobia*) *subreticulatus* sp.nov.; venation.
12. *Epiphragma* (*Epiphragma*) *risoria* sp.nov.; venation.
13. *Austrolimnophila* (*Austrolimnophila*) *croceipennis* sp.nov.; venation.
14. *Austrolimnophila* (*Austrolimnophila*) *eucharis* sp.nov.; venation.
15. *Austrolimnophila* (*Austrolimnophila*) *multitergata* sp.nov.; venation.
16. *Austrolimnophila* (*Austrolimnophila*) *nebrias* sp.nov.; venation.
17. *Paralimnophila* (*Papuaphila*) *delecta* sp.nov.; venation.
18. *Paralimnophila* (*Papuaphila*) *holoxantha* sp.nov.; venation.

Plate 2

Fig. 19. *Paralimnophila* (*Papuaphila*) *perdiffusa* sp.nov.; venation.
20. *Gynoplistia* (*Gynoplistia*) *jocosa* sp.nov.; venation.
21. *Gonomyia* (*Lipophleps*) *auchetes* sp.nov.; venation.
22. *Gonomyia* (*Lipophleps*) *bicircularis* sp.nov.; venation.
23. *Gonomyia* (*Lipophleps*) *dispar* sp.nov.; venation.
24. *Gonomyia* (*Lipophleps*) *pleurostriata* Alexander; venation.
25. *Gonomyia* (*Lipophleps*) *melanostyla* sp.nov.; venation.
26. *Gonomyia* (*Lipophleps*) *reclinata* sp.nov.; venation.
27. *Gonomyia* (*Lipophleps*) *subacus* sp.nov.; venation.
28. *Gonomyia* (*Lipophleps*) *subægina* sp.nov.; venation.
29. *Styringomyia platystyla* sp.nov.; venation.
30. *Styringomyia scalaris* sp.nov.; venation.
31. *Toxorhina* (*Ceratocheilus*) *gressitti* sp.nov.; venation.
32. *Toxorhina* (*Ceratocheilus*) *hoogstraali* Alexander; venation.
33. *Toxorhina* (*Ceratocheilus*) *infuscula* sp.nov.; venation.
34. *Toxorhina* (*Ceratocheilus*) *trichopyga* sp.nov.; venation.
35. *Toxorhina* (*Toxorhina*) *pulvinaria* Alexander; venation.
36. *Toxorhina* (*Toxorhina*) *protrusa* sp.nov.; venation.

PLATE 3

FIG. 37. *Limonia* (*Libnotes*) *viridicolor* sp.nov.; male hypopygium.
38. *Epiphragma* (*Epiphragma*) *riseria* sp.nov.; male hypopygium.
39, 40. *Austrolimnophila* (*Austrolimnophila*) *eucharis* sp.nov.; male hypopygium.
41, 42. *Austrolimnophila* (*Austrolimnophila*) *multitergata* sp.nov.; male hypopygium.
43, 44. *Austrolimnophila* (*Austrolimnophila*) *nebrias* sp.nov.; male hypopygium.
45. *Paralimnophila* (*Papuaphila*) *delecta* sp.nov.; male hypopygium.
46. *Gynoplistia* (*Gynoplistia*) *jocosa* sp.nov.; male hypopygium.

PLATE 4

FIG. 47. *Gonomyia* (*Lipophleps*) *auchates* sp.nov.; male hypopygium.
48. *Gonomyia* (*Lipophleps*) *bicircularis* sp.nov.; male hypopygium.
49. *Gonomyia* (*Lipophleps*) *dispar* sp.nov.; male hypopygium.
50. *Gonomyia* (*Lipophleps*) *melanostyla* sp.nov.; male hypopygium.
51. *Gonomyia* (*Lipophleps*) *pleurostriata* Alexander; male hypopygium.
52. *Gonomyia* (*Lipophleps*) *reclinata* sp.nov.; male hypopygium.
53. *Gonomyia* (*Lipophleps*) *subacus* sp.nov.; male hypopygium.
54. *Gonomyia* (*Lipophleps*) *subægina* sp.nov.; male hypopygium.

PLATE 5

FIG. 55. *Styringomyia melanopinax festiva* subsp.nov.; male hypopygium.
56. *Styringomyia platystyla* sp.nov.; male hypopygium.
57. *Styringomyia scalaris* sp.nov.; male hypoopygium.
58. *Toxorhina* (*Ceratocheilus*) *gressitti* sp.nov.; male hypopygium.
59. *Toxorhina* (*Ceratocheilus*) *infuscula* sp.nov.; male hypopygium.
60. *Toxorhina* (*Ceratocheilus*) *trichopyga* sp.nov.; male hypopygium.
61. *Toxorhina* (*Toxorhina*) *protrusa* sp.nov.; male hypopygium.
62. *Toxorhina* (*Toxorhina*) *pulvinaria* Alexander; male hypopygium.

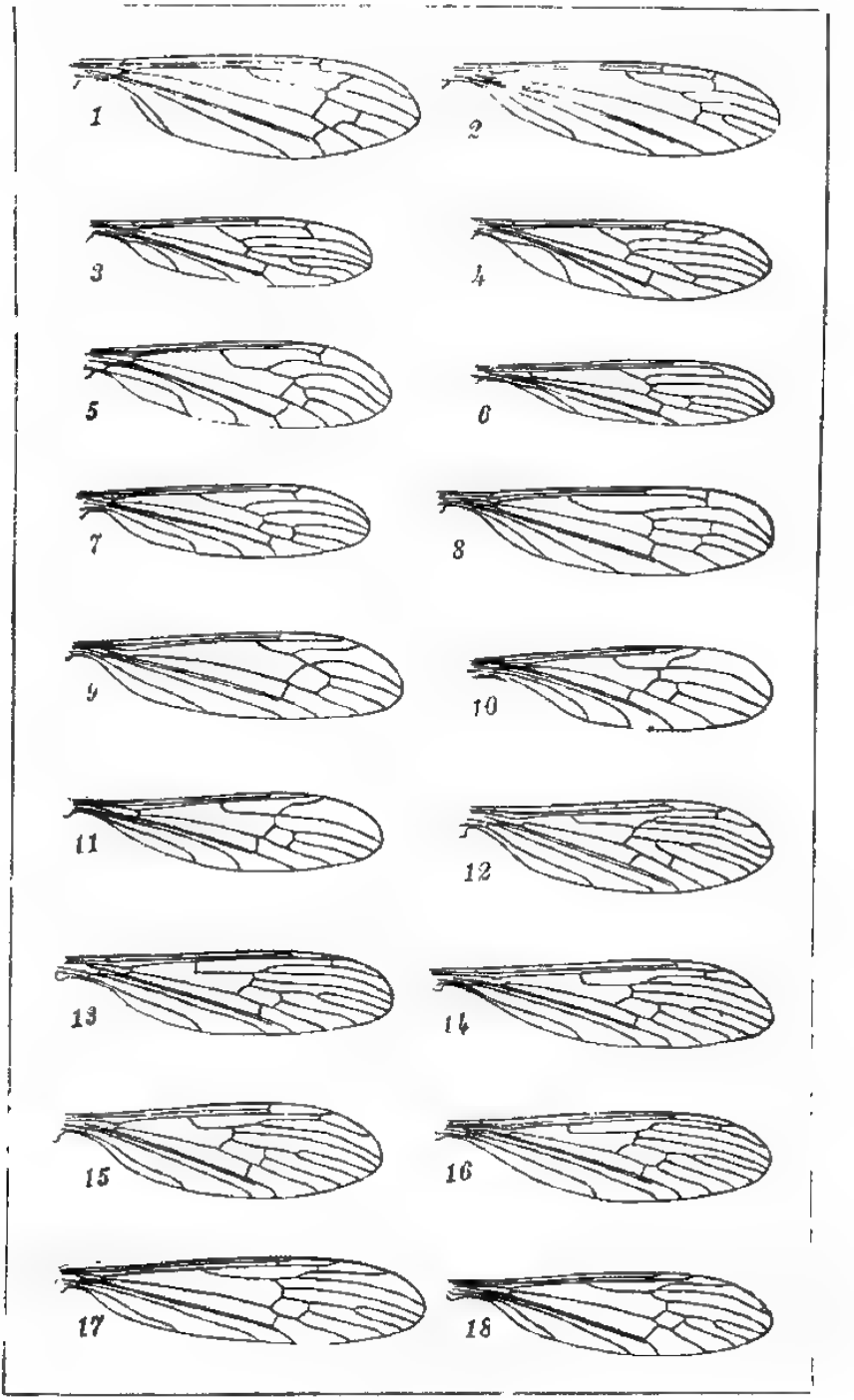

PLATE 1.

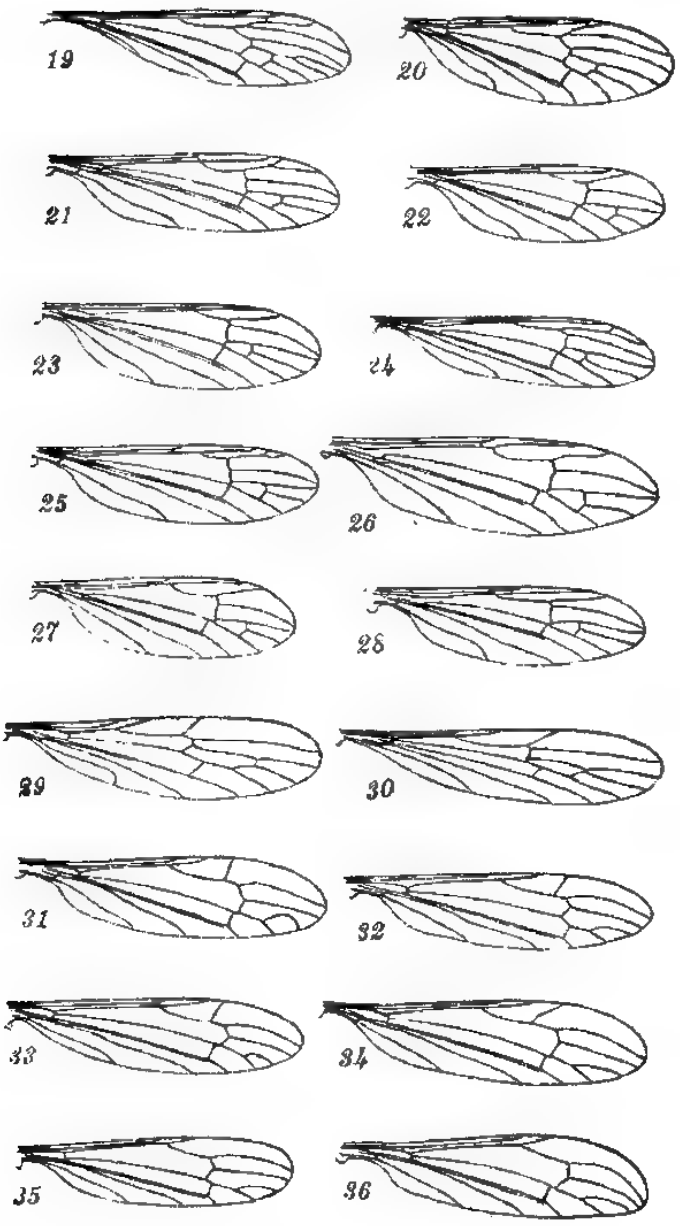

PLATE 2.

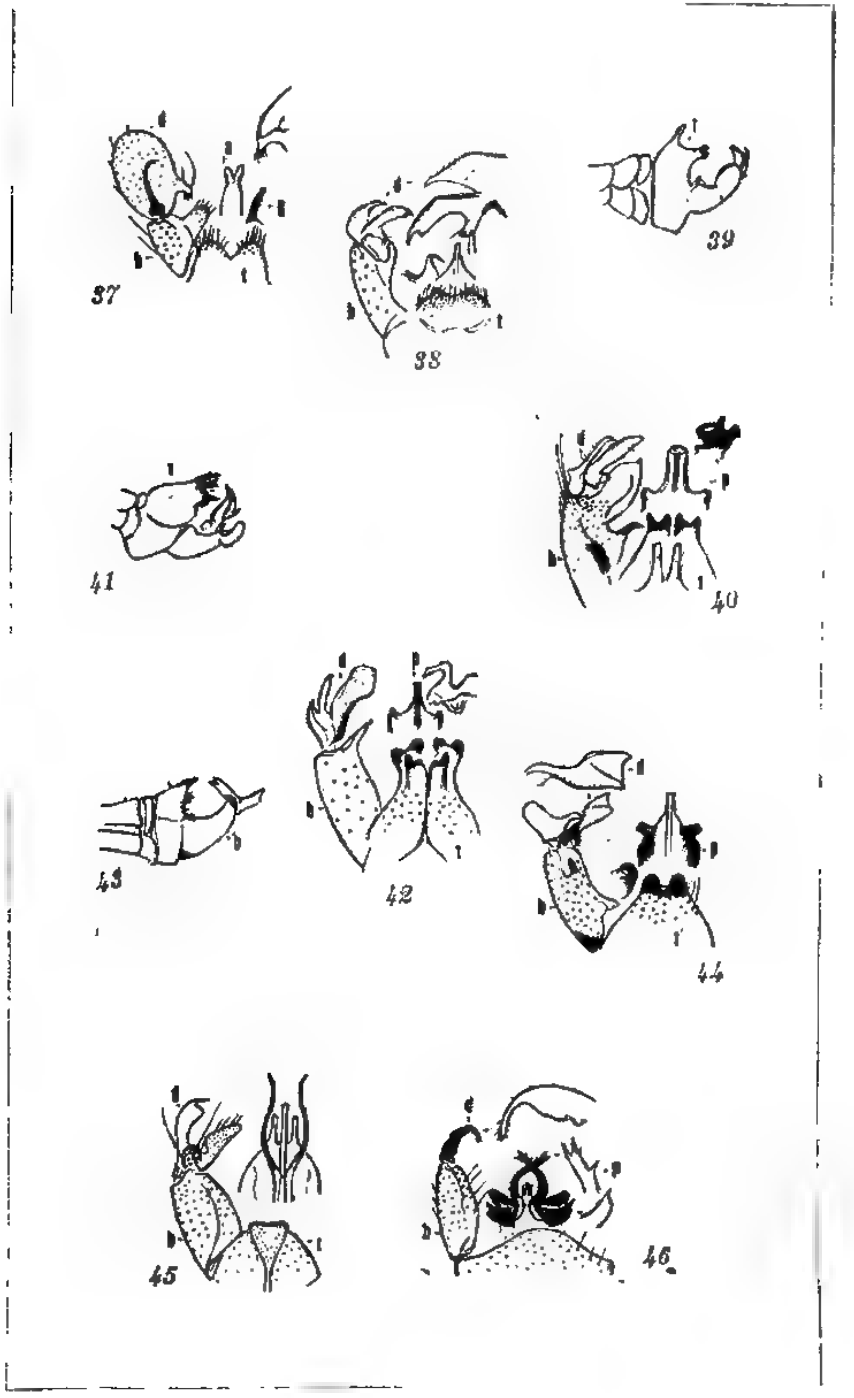

PLATE 3.

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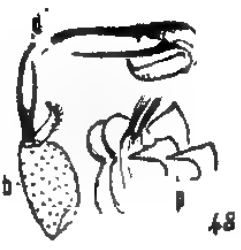

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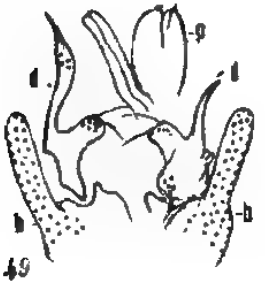

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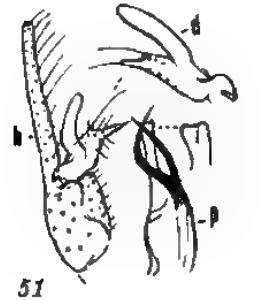

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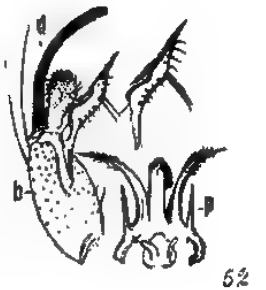

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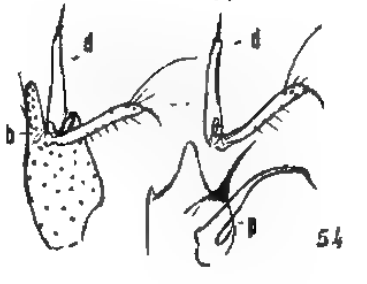

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PLATE 4.

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PLATE 5.

THE MANCHURIAN DWARF CHERRY

By A. I. Baranov
Caixa Postal 7216, Sao Paulo, Brazil

ONE PLATE

One of the centers of development of the species of *Prunus* and *Cerasus* is Eastern Asia where they number about one hundred. The majority of the species are forest trees and shrubs, but several representatives of these genera appertain to the forestless parts of Manchuria and N. China.

The northern limit of the geographic range of these groups lies in Central Manchuria, where the most hardy of the species, the most resistant of all the Manchurian cherries, appears to be the dwarf of the steppe cherry, *Cerasus humilis* (Bunge) Baranov et Liou.

All the known species of the dwarf cherries are of great value and interest in plant breeding. They are used for the development of hardy varieties for countries with adverse climatic conditions.

However, *C. humilis* is still very little known in horticulture, although it is the only species of this genus in Manchuria bearing edible fruits. Its wild relatives found in this country either have a very small size, as *C. Japonica*, or are not edible because of their sour and bitter taste, as in the case of *C. Maximoviczii*.

In order to make our shrub more popular, the writer presents in this brief note the results of his many years' study, which has been carried out in the above-mentioned parts of China.

CERASUS HUMILIS (Bunge) Baranov et Liou.

Cerasus humilis (Bunge) Baranov et Liou in Ill. Fl. Lign. Pl. N.-E. China (1955) 327, Plate 112, fig. 242.

Prunus humilis Bunge in Mem. Sav. Etrang. Acad. Sc. St. Petersb. 2 (1883) 97, Kom. Fl. Mansh. 2 (1905) 754, Schneid. Ill. Handb. Laubholzki. 1 (1906) 612; Kitagawa, Lineamenta Fl. Mansh. (1939) 269, Behd. Man. Cult. Trees and Shrubs (1947) 468.

P. glandulosa Thunb. var. *salicifolia* Koehne in Sarg., Pl. Wils. 1 (1913) 265, Kitag. *l.c.* (1939) 269 *pro syn.*

An erect, low shrub sometimes ramose, 50 cm high or higher, rarely 150 cm high.(1, 5, 6)

The root erect or horizontal, long, ligneous, 0.4 to 1.0 cm thick, sometimes creeping on the surface of the ground, sometimes under it, bearing plenty of aerial shoots, which are usually about 0.3 cm thick at the base, about 0.15 cm thick in middle part, and about 0.1 cm at the apex. (Plate 1, fig. 1.)

The specimens of this cherry coming from North Manchuria have a very characteristic habit of growth in springtime. Because almost the entire upper half of the branchlets freeze and die in winter, the young shoots and flowers are produced only in their lower parts in spring. (Plate 1, fig. 7.)

Young branchlets of the shrub are with reddish-brown bark, pubescent. Old ones are with dark brown or, sometimes, grayish bark, glabrous.

The buds in the basal part of the shoots are solitary, small, about 0.1 cm long, semiovate or semiorbiculate, rounded at the apex, compressed and adpressed to the stem, grayish-brown, glabrous. Leaf-scar convex, small, indistinct. The buds in the middle part of the shoots are larger, 0.1 to 0.2 cm long, arranged in groups of 1–3–5, semiovate or broadly semiovate, rounded or pointed at the apex, red-brown or red, glabrous, lustrous, sometimes partly very shortly pubescent, adpressed to the stem. Leaf-scar big, elevated, ovate or reniform. The buds in the upper part of the shoots are broadly ovate or semiovate, glabrous or partly pubescent, sitting in groups of 3. Cicatrix big, prominent. (Plate 1, fig. 4–6.)

The leaves of the fertile shoots are narrow, obovate or elliptic, 2.5 to 5.0 cm long, 0.8 to 1.8 cm broad, acute or short acuminate, cuneate at the base, indistinctly biserrate, glabrous, dark green above, underneath paler, glabrous or with few hairs on the midrib. The leaves of the young sterile shoots are usually larger and pubescent. Petioles are about 0.3 cm long. (Plate 1, fig. 2.)

The stipules are linear, glandulose, ciliate (Plate 1, fig. 3). They are persistent on the young shoots, while on the old and fertile ones they exist only in the spring and soon fall off.

The flowers, clustered in groups of 2 to 3, or solitary, are about 1.5 cm across and sit on short, 0.6 to 0.8 cm long, pubescent pedicels.(5) The 5-lobed calyx has free and distinctly denticulate green sepals, which are as long as the hypanthium (Plate 1, figs. 8, 9). The latter is crateriform, about 0.3 cm across and 0.5 to 0.8 cm long, pink, outside sparsely pubescent (Plate 1, figs. 8, 9). Petals 5, ovate, about 0.6 cm long (Plate 1, fig. 11). Stamens 35 to 37 in number, sitting along the upper

margin of the hypanthium. Pistil bottle-shaped, with green, smooth, glabrous, ovoid ovary and pink style, longer than the stamens, ended with the erect or somewhat nodding stigma. (Plate 1, figs. 8, 9, 10.)

There exist 2 varieties of *C. humilis* distinguished by the color of their petals. The first, var. *albiflora* Skvortz., is white; and the second, var. *rosea* Skvortz., is pink. Both of them were collected by B.V. Skvortzow on the dry slopes of hills in the vicinity of Harbin.(7)

The drupes of the dwarf cherry are globose or slightly oblong, comparatively long-stalked, 1 to 2 cm across, red in color.(1, 5) (Plate 1, figs. 12, 13.) They are frequently furnished on the apex with a small structure having the form of a dry tubercle. This structure is nothing else but the persistent base of the style. The stone is ellipsoid or ovoid, either acute on both ends, or truncate on one end, smooth (Plate 1, fig. 14). The seed, covered with yellowish-brown seed coat, longitudinally brown-striped, consists of 2 smooth, white cotyledons, with an embryo about 0.1 cm long between them. (Plate 1, figs. 15, 16, 17.)

Bunge, who was the first to collect and describe our dwarf cherry, referred it to the genus *Prunus*.(1) However, morphological characters of its fruits, such as long stalk, absence of the bluish-pruinose cover, stone not flattened, but subglobose, ellipsoid or ovoid and smooth, correspond to the genus *Cerasus*.(2) Therefore, the present writer transferred this species to this group. This new combination was published by him in 1955.(3)

Relationship.—There exist 2 other dwarf cherries similar to our *C. humilis*; the first is *C. glandulosa* (Thunb.) Lois., bound to the sunny slopes and rockeries of Eastern Manchuria, Korea and Russian Far East; and the second is *C. fruticosa* (Pall.) G. Woron., sometimes also called *C. humilis* Hort. The latter grows in the steppes, on dry slopes, and along the forest margins of Central Europe, Central and Eastern European Russia, Western Siberia, Caucasus and Central Asia.(2) Both of these shrubs are quite different from, and have nothing in common with, our *C. humilis*.

The mentioned 3 species of *Cerasus* can be easily distinguished from one another by the following analytical key:

Key to the species of Cerasus

1. Leaves glandulose-serrate. Flowers not bracteate. Petals sinuate at the apex. Calyx tube twice as long as the sepals. Drupes comparatively large, 1 to 2 cm across ..... *C. fruticosa* (Pall.) G. Woron.
1. Leaves not glandulose-serrate.

2. Flowers bracteate. Drupes small in size, 7 to 8 mm across. *C. glandulosa* (Thunb.) Lois.
2. Flowers not bracteate. Petals not sinuate at the apex. Sepals equal to the calyx tube. Drupes comparatively large 1 to 2 cm across ..... *C. humilis* (Bge.) Bar. et Liou.

Distribution.—General distribution of *C. humilis* is as follows: North China (Shangtung, Hopei), Korea and Manchuria.(1, 4, 6, 7, 11) Some authors have reported it growing in Eastern Siberia, but this is denied in the Flora URSS.(2)

In North Manchuria it grows through the forestless part of the former Kirin Province; in the Harbin Region; and in the valley of the rivers Sungari, Ashiho, and Mutankiang.(8)

This shrub is also very frequently seen in South Manchuria, and has been reported from several localities in Jeho.(4)

The dwarf cherry was collected by D.I. Litvinov in Liaotung Peninsula, by T. P. Gordeiev and B. V. Skvortzow in North Manchuria, and by several Japanese and Chinese botanists in the southern as well as in the northern parts of this country.(1, 4, 6, 7, 8, 11)

The writer had studied *C. humilis* for many years during his field explorations in the different regions of Manchuria; in the herbaria of Harbin Museum, Institute of Forestry and Soils of Academia Sinica in Mukden; and in the collections of Mr. Miura, who found it in the former Mukden Province.

This plant always occurs on dry, grassy slopes of hills and uplifts, on sand or gravelly soils. In 1939 the writer surveyed the growth of this cherry in the southern suburbs or Harbin. It was extremely abundant there, sometimes occupying large stretches of sunny slopes of terraces in the valley of Sungari River.

However, in our days the once enormous natural plantations of *C. humilis* are in great decrease because of the harmful influence of the steppe fires and of clearing and cultivation of soil. Undoubtedly it was distributed more widely and played an important role in the formation of the plant cover of the so-called Elm Semisteppe in Central Manchuria in prehistoric times.

The fact that in North Manchuria this shrub suffers from winter frost and bears fruits of lesser size than in the southern part of this country, perhaps indicates that its native countries are North China and South Manchuria, and that North Manchuria is the northern limit of its distribution.

Cultivation.—From the horticultural point of view *C. humilis* has certain important qualities—a strong root system, resistance to draught and cold, ability to regenerate easily after being destroyed, and high yielding capacity.

The fruits are produced abundantly (for example, 1 bush cultivated in Harbin gave yearly 7.5 kg of the same) and ripen in the middle of August. They are juicy, fleshy, and very aromatic; but the amount of juice, the thickness of flesh, the flavor, shape and size vary very much. They are usually large enough, the fleshy part being about 0.75 cm thick and good for eating; they are rarely inedible—small, bitter, and acidic. Chinese often collect them in great quantities for eating raw or for making preserves. The high fruitfulness of *C. humilis* makes it, according to A.D. Woeikoff, a good fruiting shrub; but the fruits are of a quality different from European cherries.(10)

This plant also may be used as an ornament in the garden, but its greater value for the horticulturist lies in its hardiness. This quality makes it best utilized in cross-breeding experiments and in grafting.

There is no doubt that this cherry was for a long time cultivated by Chinese and that they have several garden varieties. P.S. Ignatzius, an old resident of Manchuria, has told us, in this connection, that in the beginning of this century near the small town of Botune, situated on the bank of the Sungari River, between Kirin and Harbin, there existed big orchards of our dwarf cherry which were under the supervision of a special official whose duty was to supply the Imperial Court at Peking with preserves made of its fruits. This cultivated variety of *C. humilis* was called "The Cherry of Kang-Hsi" because this emperor was very fond of it.

At present this shrub is cultivated only by amateurs and on a very small scale. It can be occasionally met in the gardens of Harbin, Acheng, Yaomen and Hsingyaocheng. At any rate the writer had never seen in Manchuria big and special dwarf-cherry plantations. In the United States this species of cherry was introduced in 1881, but it is not clear how widely it is now cultivated there.(5)

C. humilis may be propagated by sowing stones, by grafting, and by division. The experiments of its cultivation in Harbin between 1937 and 1939 were quite successful. N.V. Gloukhov, who conducted the experiments, told the writer that stones of the dwarf cherry were stored with wet sand in the winter of

1937–38 and then sown in the beds in June, 1938. They immediately began to sprout vigorously, and in May, 1939 (i.e., in less than a year) approximately 50 per cent of the seedlings began to bloom. During 15 months of their life these plants gave robust shoots up to 115 cm tall. Such a stature, however, may be attained by cultivated specimens only.

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ILLUSTRATIONS

[Fig. 1, Reduced approximately 20 times; figs. 2, 12 and 13, reduced about twice natural size; figs. 4 and 7, reduced approximately 4 times; figs. 3, 5, 6, enlarged about 3 times; figs. 14, 15, and 16 enlarged about 3/4 times; fig. 8, enlarged about 2 times; figs. 9, 10, and 11, enlarged about 8 times; fig. 17, enlarged about 10 times.]

PLATE 1

FIG. 1. General habit of plant.
2. Leaves.
3. Stipule.
4. Portion of a branchlet in winter with buds.
5. Buds and leaf scars (front view).
6. Same (side view).
7. Portion of a branchlet in spring, bearing clusters of flowers at base of young shoots. Upper half of branchlet is frost bitten.
8. Flower (general view; petals removed).
9. Longitudinal section of flower.
10. Pistil (hypanthium removed).
11. Petal.
12. Drupes.
13. Longitudinal section of drupe.
14. Stones.
15. Seed.
16. Two cotyledons of seed and embryo.
17. Embryo.

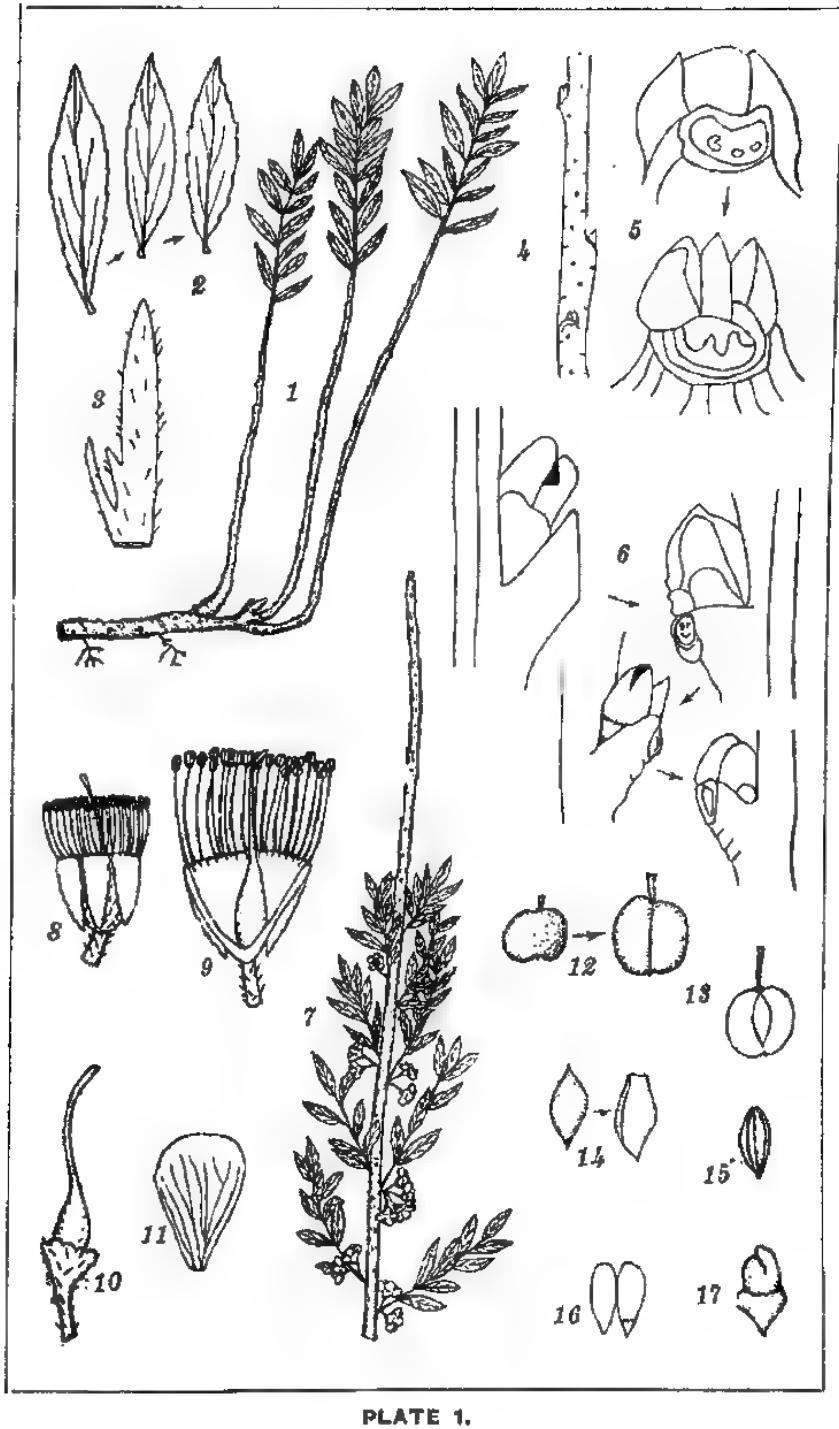


PLATE 1.

OBITUARY

Gregorio E. Edaño
1896–1960

Gregorio E. Edaño, a renown plant collector, died on May 10, 1960, after a lingering illness. His passing was deeply felt not only by the National Museum, with which he had been connected for many years, but also by botanists the world over who had known him for his life work.

Gegorio E. Edaño was born to Valentin Edaño and Raymunda Estrada in Dao, Capiz, on May 9, 1896. He took his elementary education in his hometown, but barely finished it when, by chance, he met an American to whom he attached himself. His adventurous spirit subsequently led him to escape from his family, landing in Manila which was to be his permanent home up to the time of his passing.

Once in Manila, in May 1911, he found work at the age of 15 as a temporary helper in botany in the Bureau of Science. In 1916, having gained some experience in plant collecting, he made his first botanical trip with Maximo Ramos, then the senior collector of the Bureau, who, like himself, was working under Dr. Elmer D. Merrill. Edaño with Ramos explored the forest regions of Nueva Ecija, in Luzon, touching Umingan, Mt. Dingalan and Mt. Tulang. From then on he made plant collecting his specialty in the government service which ended with his death at the age of 64, exactly a year before his scheduled retirement therefrom.

Before the Second World War, he invariably went with Maximo Ramos in exploring botanically the untouched forest regions and mountain peaks of the Philippines. He also went afield with American botanists, such as Drs. Merrill himself, Brown, and Elmer, from whom he learned better techniques in plant collecting. After the death of Ramos in 1932 in the wilderness of Mindanao, Edaño became the chief plant collector of the Bureau of Science.

After the war, he continued to serve as plant collector of the National Museum. He criss crossed the country several times, collecting botanical specimens in virgin forests and in such

mountain heights as Mts. Apo, Bulusan, Canlaon, Halcon, Pulog, and Cuernos de Negros. With great hazards to his life in carrying out his duties, he climbed steep slopes and precipices; crossed streams and jungles infested with deadly animals; and slept in the open country exposed at times to the inclement weather, to hunger and disease. Yet all the time he showed stamina, perseverance, and industry—qualities which marked his exemplary service in the government.

All his best years were spent in plant collecting, especially in collecting ferns and flowering plants, for the benefit of science. As a result of his efforts, many unknown Philippine plants were brought to light identified, described, and studied for the development at botanical science and the improvement of the economic life of his country.

In recognition of his meritorious work, science has seen it fit to perpetuate the name of Edaño in botanical literature. In appreciation of his exemplary work, Dr. Merrill named after him: *Begonia edañoii, Cryptocarya edañoii, Ficus edañoii, Loranthus edañoii, Rubus edañoii, and Phychotria edañoii.* Dr. W. Becker had honored him in *Viola edañoii.* Drs. Merrill and E. Quisumbing had remembered him in *Ophiorrhiza edañoi, Rhododendron edañoi,* and *Urophyllum edañoi.* Dr. Edwin B. Copeland, the foremost pterodologist of the Philippines and Malaysia, had singularly honored him by naming a new fern genus, *Edanyoa,* after him. Dr. Copeland, in addition, had remembered him in four ferns species *Bolbetis edanyoi, Cyclosorus edanyoi, Cyathea edanyoi,* and *Polystichum edanyoi.*

In the field of taxonomic botany Edaño was well known by many botanists the world over for the thousands upon thousands of specimens collected by him, which are now found in the herbaria of America, Europe, Asia, Indonesia, Japan, and Australia, not to mention the Philippine National Herbarium which contains all his original collections after the war. In distinct recognition of his life work, the Flora Malesiana has included his name as one of the outstanding plant collectors of the world.

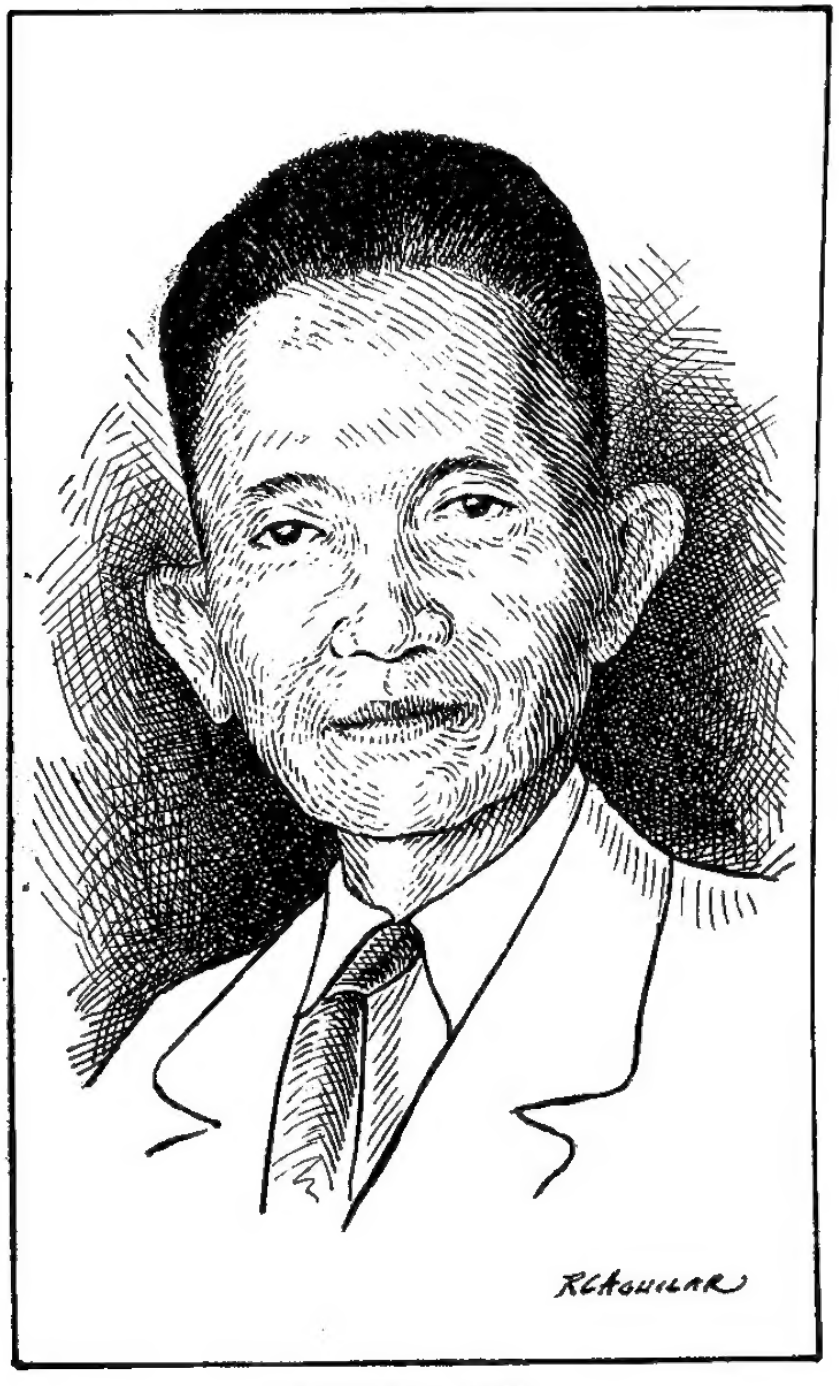
Localities in islands and provinces covered by Edaño in his botanical explorations are shown in the following table. When Edaño was not on an extended field trip, he invariably made his collections in Manila and the neighboring towns.—D.R.M.

1916—Luzon: Tayabas, Mt. Dingalan, Mt. Tulang, Umingan*
1917—Luzon: Tayabas, Mt. Bimuan, Umiray River*
1918—Luzon: Camarines Norte, Mt. Bagacay, Paracale*
1919—Panay: Capiz, Mt. Libacao, Mt. Salibong-bong
1919—Mindanao: Zamboanga, Mt. Tuba, Malangas*
1920—Mindanao: Bukidnon, Mt. Candoon, Mt. Camates, Mt. Dumalupihan*
1920—Luzon: Mt. Province, Mt. Polis, Mt. Pulog, Bontoc*
1921—Luzon: Mt. Province, Mt. Baduan, Benguet and between Mankayan and Baguio*
1922—Mindoro: Mt. Halcon*
1924—Sulu Archipelago: Tawi-tawi and neighborhood*
1924—Luzon: Zambales, Mt. Marayop, Mt. Pinatubo, Mt. Tapulao*
1925—Luzon: Mt. Province, Mt. Baudan, Benguet*
1925—Luzon: Tayabas, Mt. Alsapan and Casiguran*
1925—Luzon: Nueva Ecija, Mt. Alsapan*
1926—Luzon: Isabela, San Mariano*
1926—Luzon: Rizal, Mt. Moises, Mt. Irid *
1927—Palawan: Balabac*
1927—Mindanao: Davao, Mati, Limot, Mt. Mayo*
1928—Catanduanes: Virac, Mt. Abucay, Simamla and Dakulang patag*
1928—Luzon: Camarines Sur, Mt. Potianai, Agosai*
1929—Palawan: Mt. Manalsal, Tigpalan and west of Brooke's Point
1929—Luzon Northern: Mt. Cagua, Mt. Balantogan
1930—Luzon: Cagayan, Northern part*
1930—Luzon: Nueva Ecija, Mt. Alsapan
1930—Camiguin and Babuyan: Mt. Hibok-hibok
1946, Sept.–Dec.—Mindanao: Davao, Mt. Apo, Mt. McKinley, Baclagon, Madaum River, Miran River, Taglawig, Mace**
Mindanao: Cotabato, Bugasan, Parang
Mindanao: Lanao, Lake Lanao and Lanao-Cotabato boundary
1947, Mar.–May—Palawan: Mt. Mantalifigajan, Lapulapu, Bacuñgan, Brooke's Point, Puerto Princesa, Canigaran, and Babuyan Island
1947, Nov.–Dec.—Luzon: Bataan, Mt. Kuyapo, Mt. Palacio Lamao
1948, Feb.–May—Mindoro: Mt. Halcon, Mt. Ilong, Mt. Baco
1948, August—Negros Oriental, Cuernos de Negros, Lake Danao, Lake Balinsasayao, Guinsuan Creek, Malangko, Sibulan, Mt. Balbug, and Inabacan River.
1949, March Mindanao: Davao, Mt. Bilbagan, Mt. Kampalili, Mt. Mansanuga, Mt. Mayo, Mt. Pagpawan, Mayo River, Quinonoan River, Baguan River, and Pujada Island
1949, May—Negros Oriental: Lake Balinsasayao
1949, August—Mindanao: Davao, Mt. Hamiguitan, Mt. Mansamuga, Mt. Kapok, Titiban, Magdug River and Limut Point.
1950, Mar.–May—Leyte: Lake Danao, Mt. Mamban, Mt. Hanagdan, Antilao River
1951, March—Palawan: Victoria Peaks, Mt. Iraan, Tarateon River, Maglasgao River, Talakaegan River, Aborlan

* With Maximo Ramos
** With Dr. Hoogstraal

1951, Dec.–1952, Jan.—Samar: Mt. Capotoan, Mt. Sarawag, Mt. Cabayanan, Mt. Purog, Masbog River, Matuguinao•••
1953, Feb.–Mar.—Luzon: Ilocos Norte, Mr. Quibrada, Mt. Pico de Loro, Mt. Darna, Banua, Cabaritan River, Mt. Candung-candung, Mt. Magnas, and Mt. Duraraga.
1954, Mar.–Apr.—Negros Oriental: Mt. Canlaon, Mt. Katugasan, Kinabkaban River
1956, Jan.–Mar.—Luzon: Albay, Mt. Malinao
1956, June—Luzon: Sorsogon, Mt. Juban
1957, Jan.–Apr. Zoological-Botanical Expedition with a chartered ship by Mrs. King of Hawaii, touching on the Bisayan Islands, Mindoro, Palawan, Sulu Archipelago, Turtle Islands, and Sandakan, B. N. B.••••
1957, May—Luzon: Sorsogon, Mt. Bulusan and Mt. Irosin•••••
1958, June–July—Luzon: Laguna, Mt. Makiling
Luzon: Rizal, Antipolo
Luzon: Camarines Sur, Sipocot
Luzon: Mt. Province, Mt. Santo Tomas and Baguio••••••
1959, June—Luzon: Batangas, In Batangas and Nasugbu Bay•••••••

••• With P. Gachalian
•••• With Dr. Kondo of Bishop's Museum
••••• With H. Gutierrez
•••••• With Mr. James Sinclair of Singapore Botanical Gardens
••••••• With G. Alcasid



GREGORIO E. EDAÑO

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